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Yamada et al.

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(54) **NOISE FILTER AND WIRE HARNESS**

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(57) **ABSTRACT**

A noise filter includes a filter circuit including a noise reduction element that reduces a noise component, a conductive first circuit connection member to which a first connection portion of the noise reduction element is electrically connected, and a conductive second circuit connection member to which a second connection portion of the noise reduction element is electrically connected, and an electric connection structure that electrically connects an intermediate connection portion of a core wire of an electric wire to one of the first circuit connection member and the second circuit connection member. The electric connection structure includes a circuit side connection body provided in one of the first circuit connection member and the second circuit connection member and indirectly or directly electrically connected to the intermediate connection portion by an elastic force indirectly or directly exerted on the intermediate connection portion.

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H01R 4/48 (2006.01)
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H01R 4/60 (2006.01)
H03H 1/00 (2006.01)

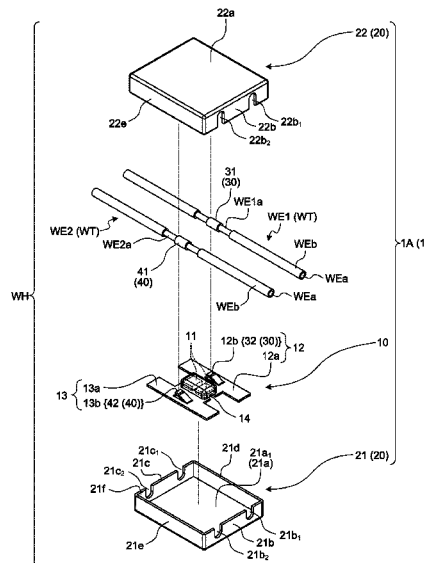
(52) **U.S. Cl.**

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(58) **Field of Classification Search**

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USPC 439/620.05, 620.21
See application file for complete search history.

7 Claims, 20 Drawing Sheets



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FIG.2

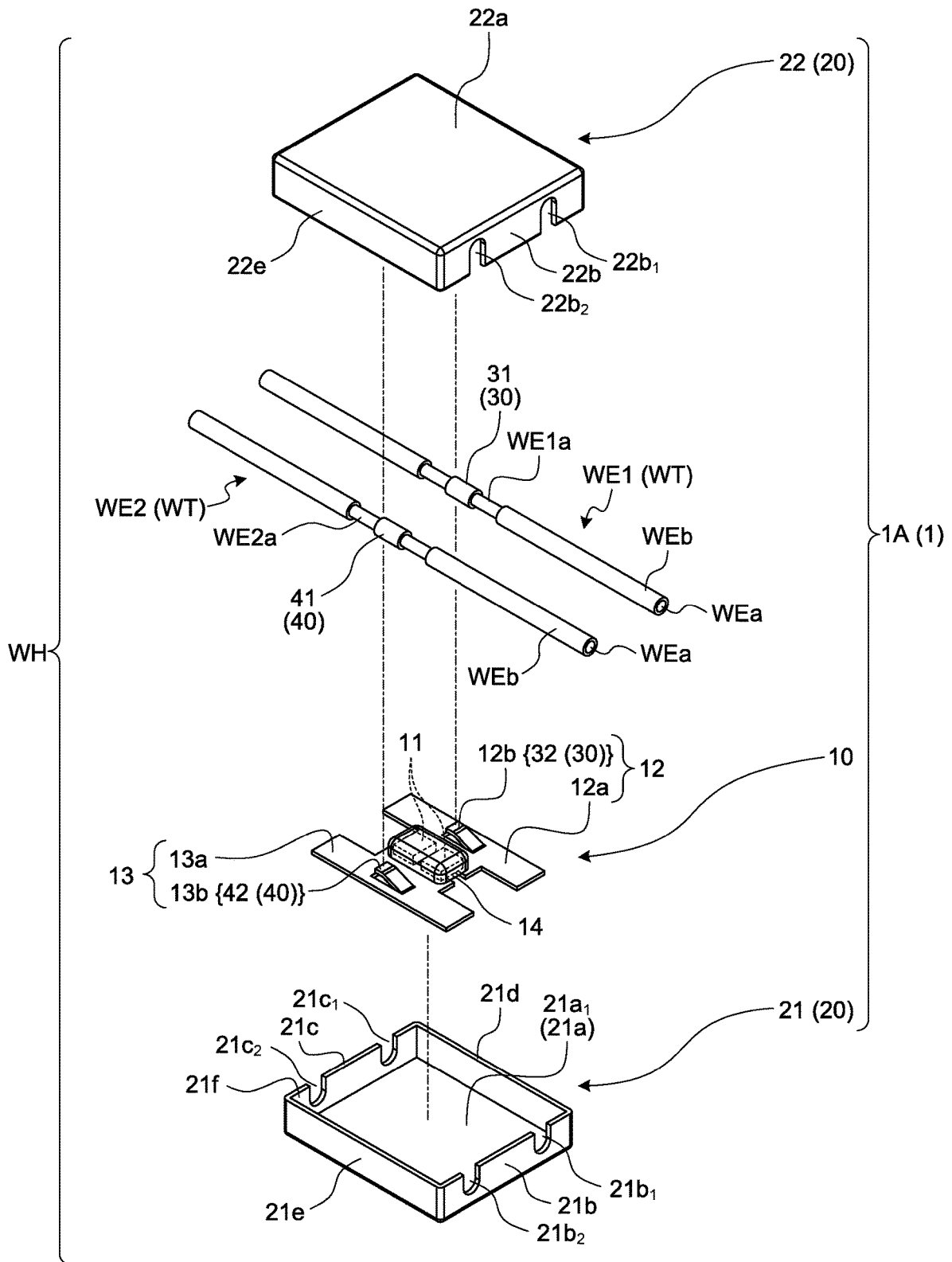


FIG.3

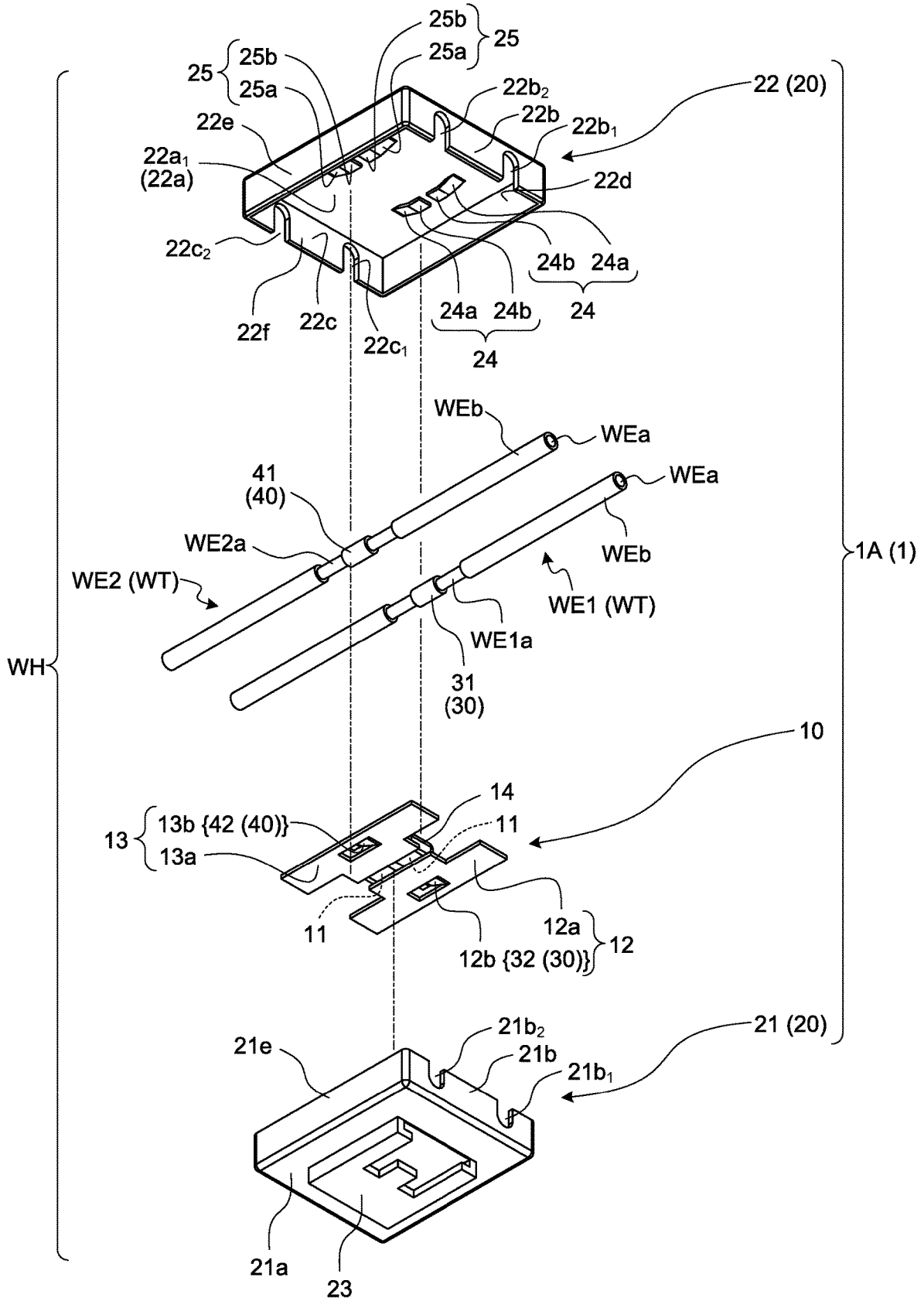


FIG.4

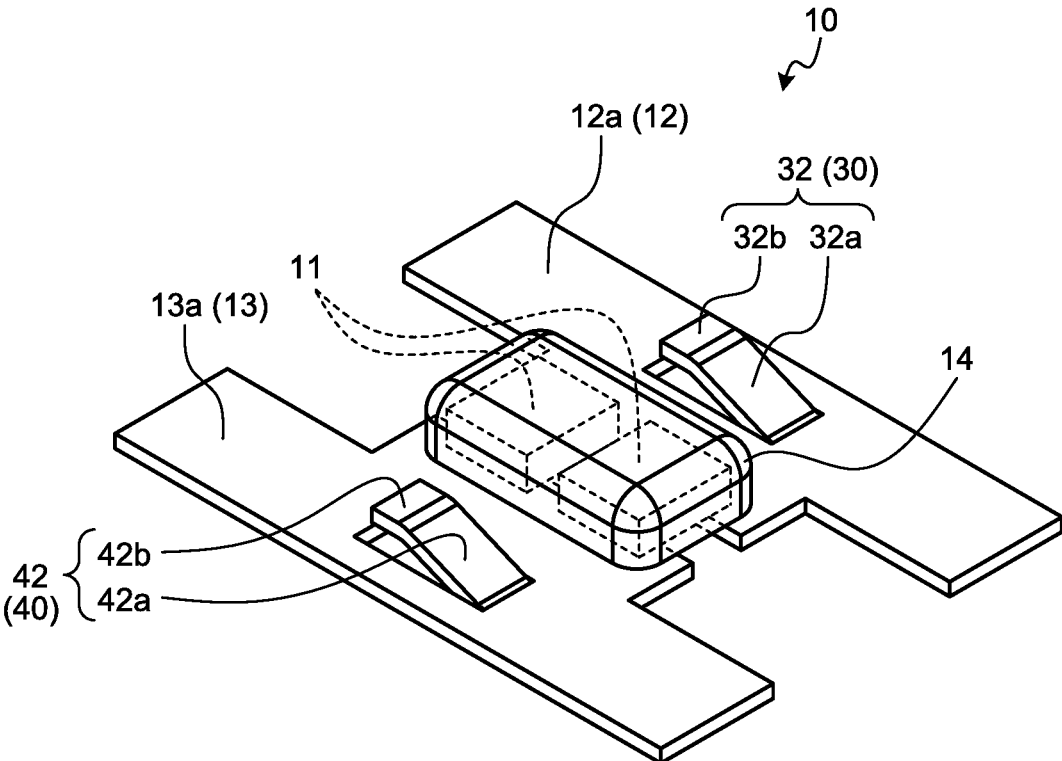


FIG. 5

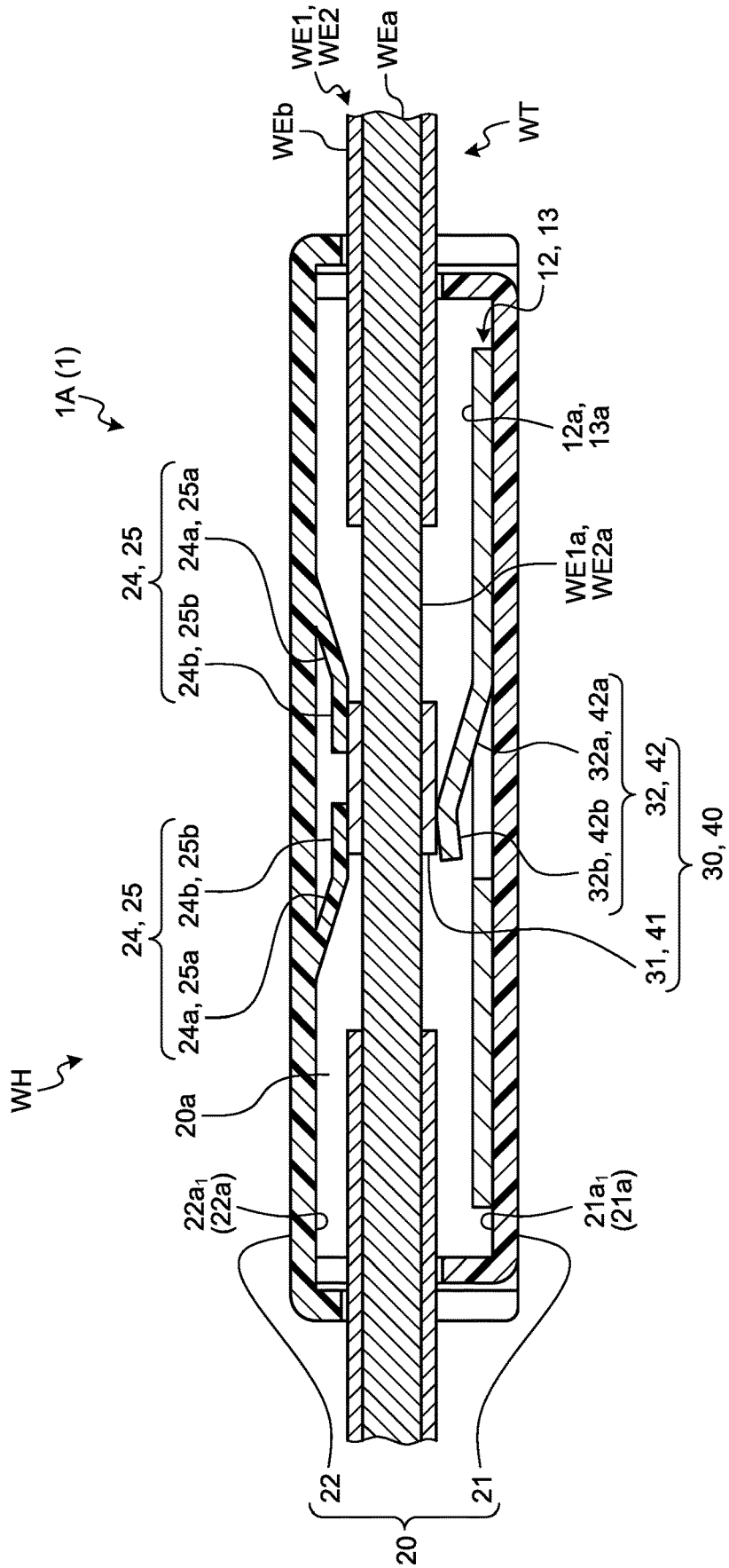


FIG.7

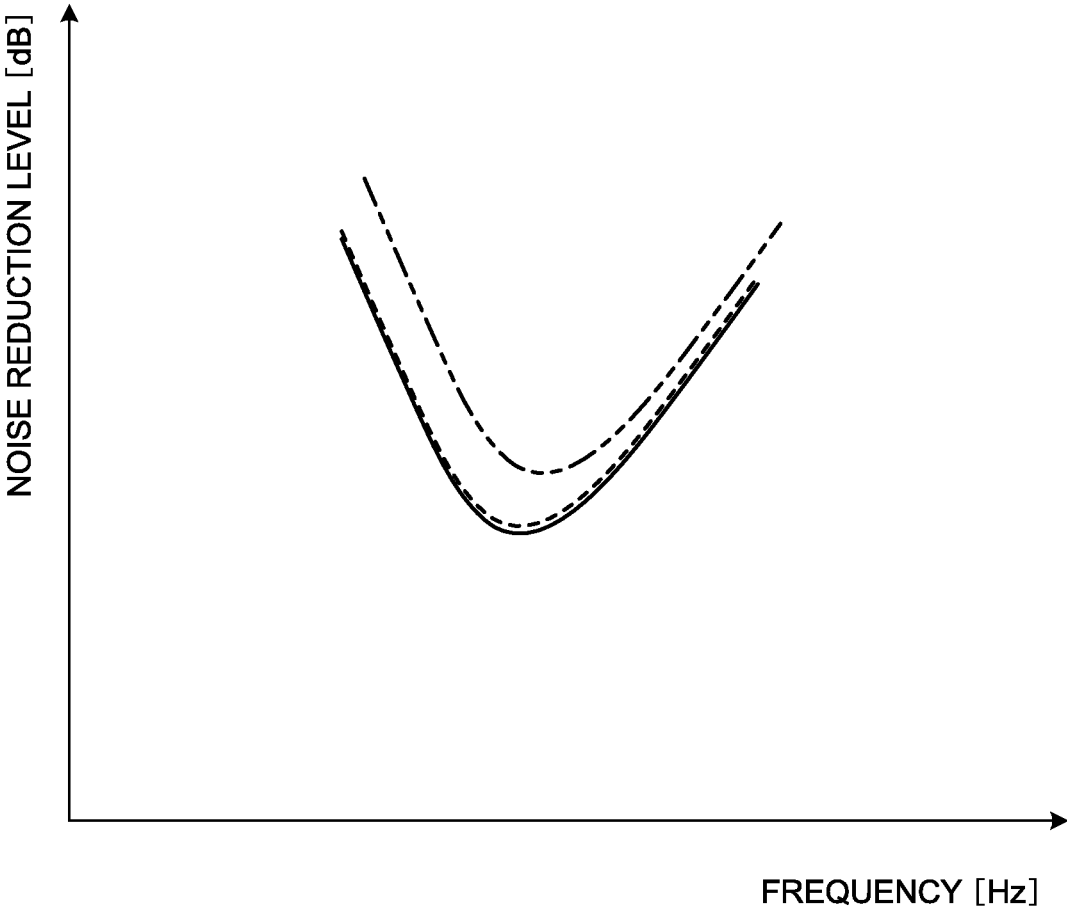


FIG. 8

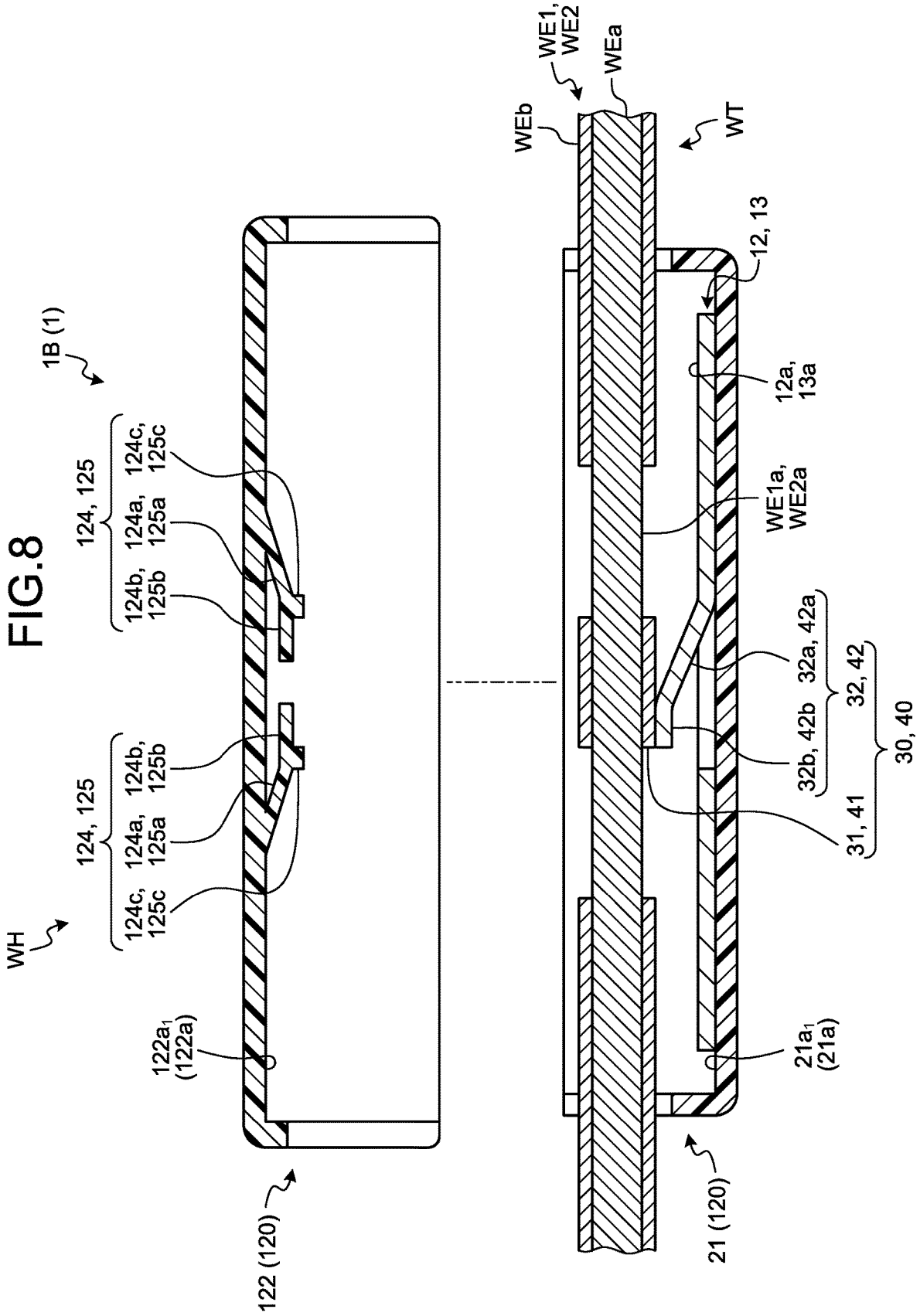


FIG. 9

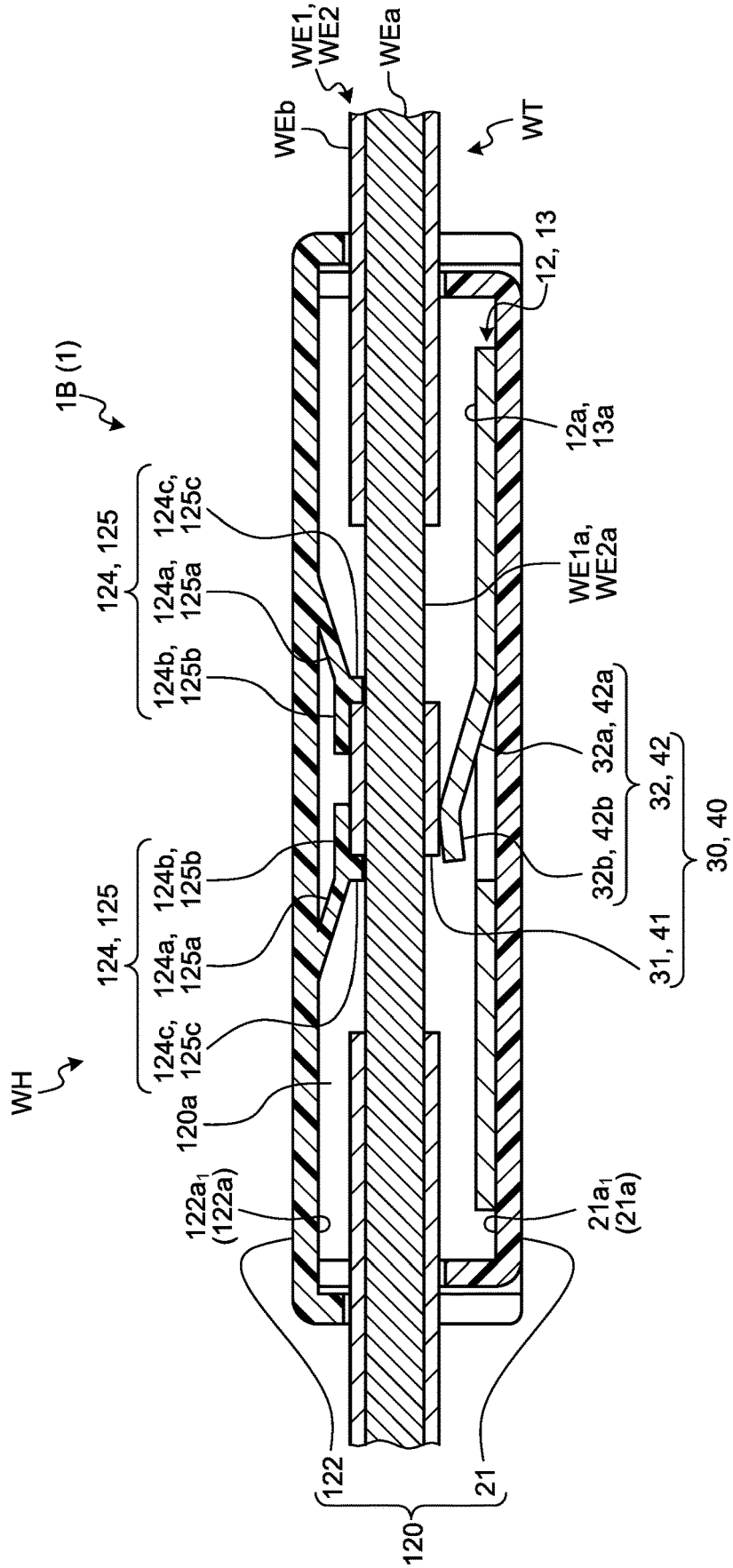
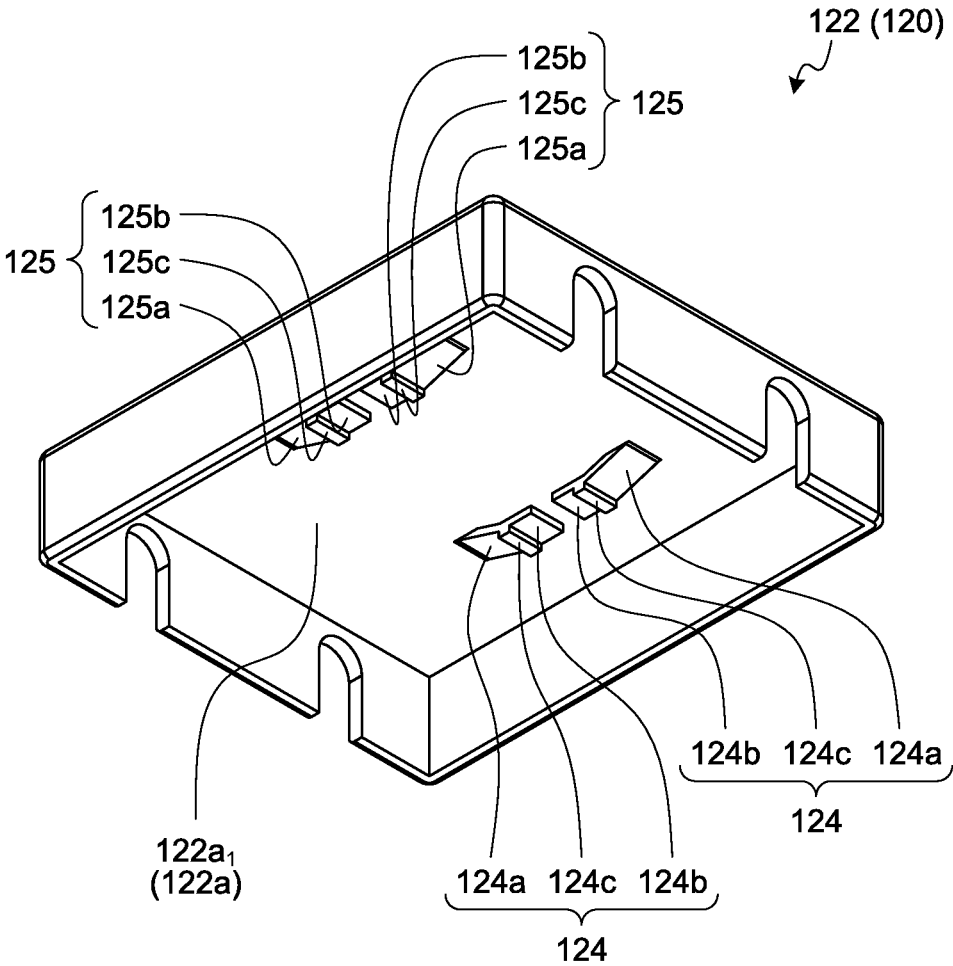


FIG.10



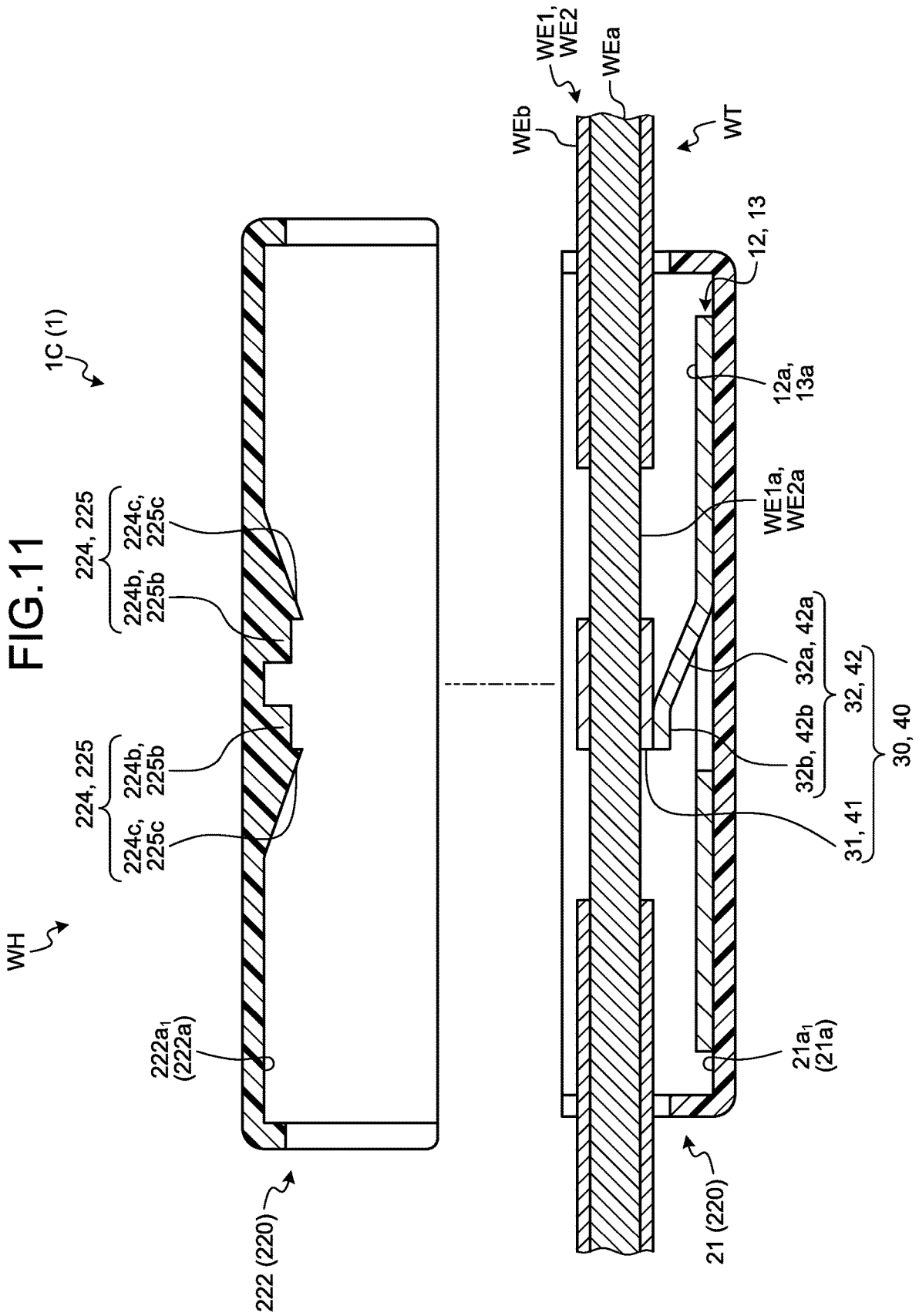


FIG. 12

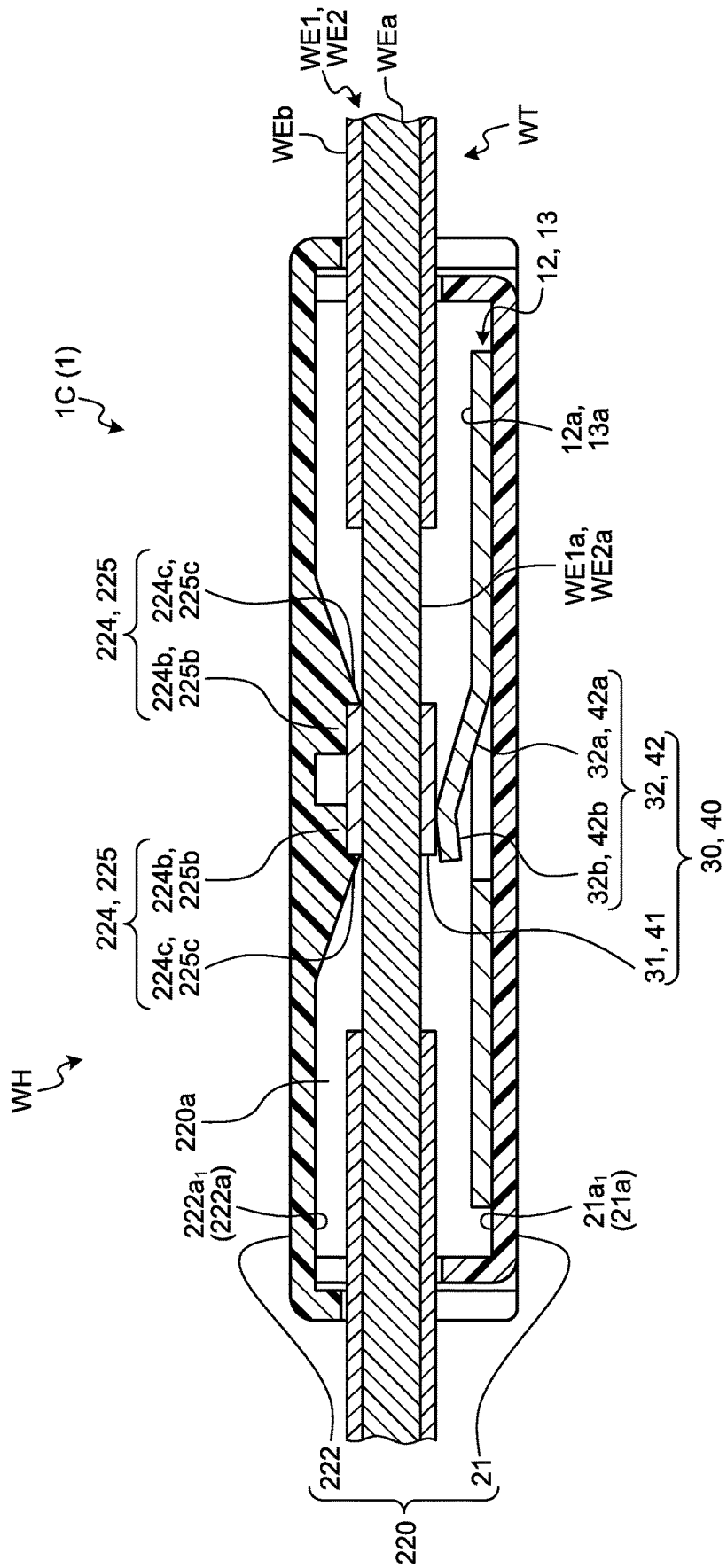


FIG. 13

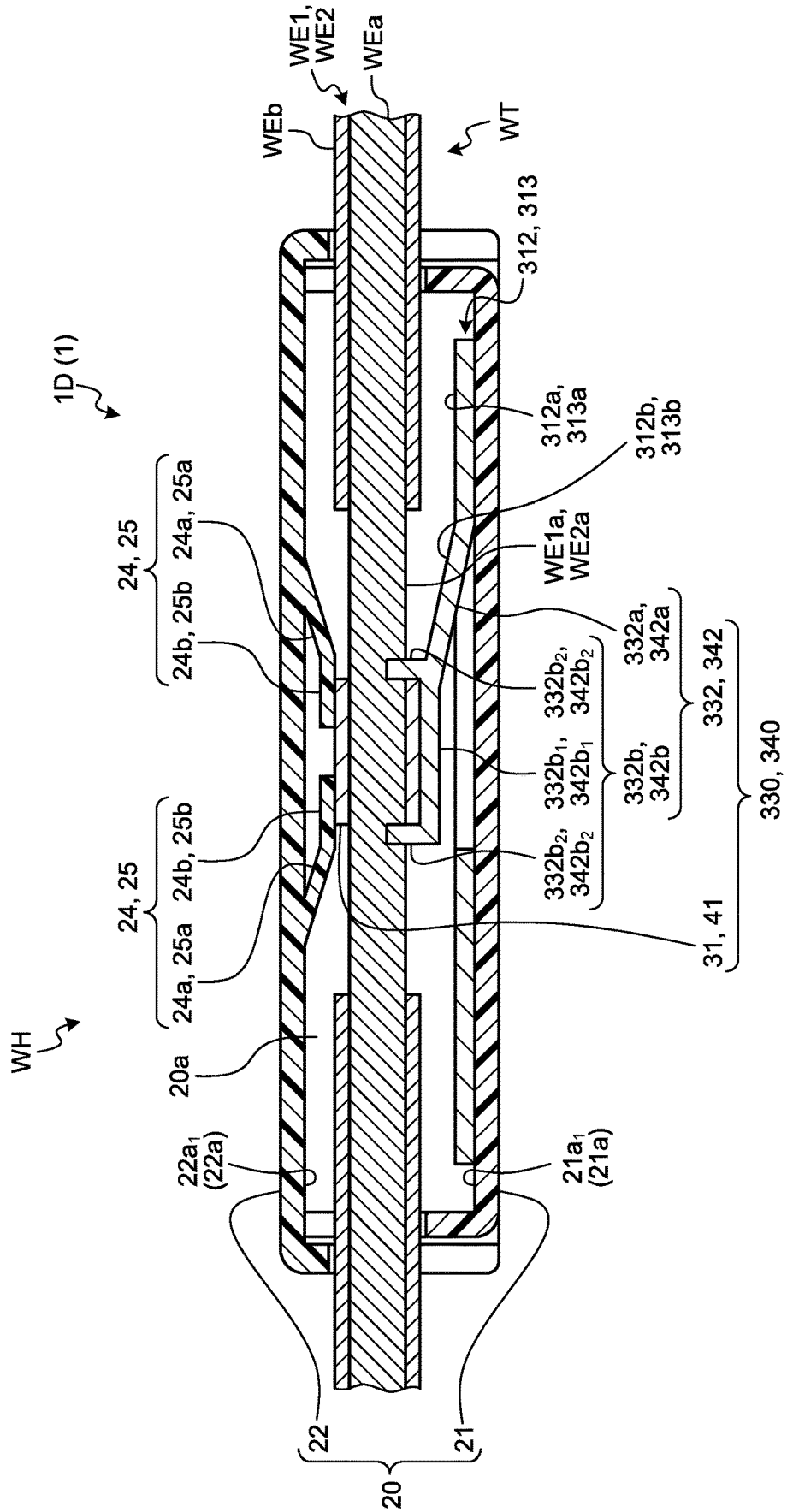


FIG. 14

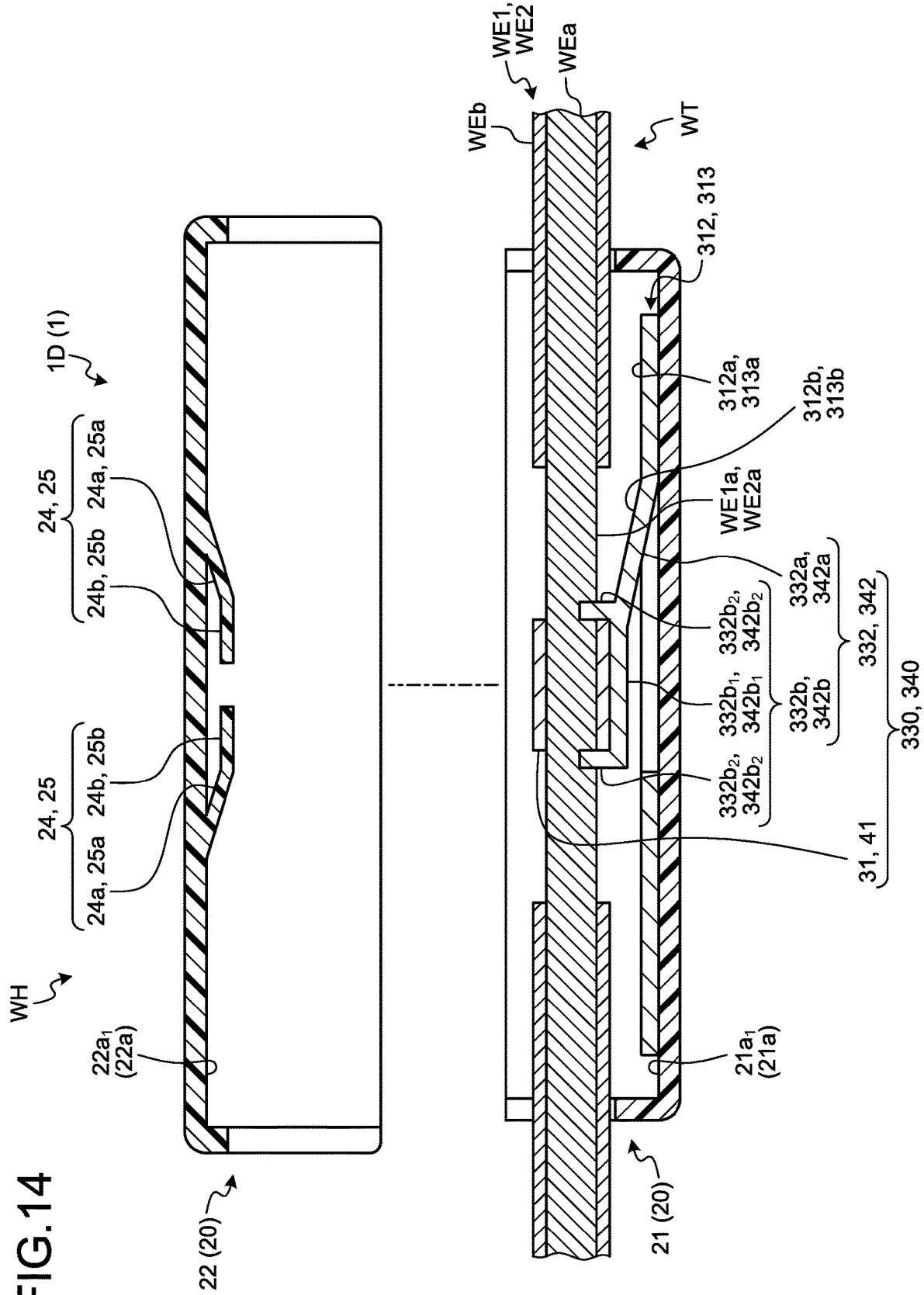


FIG. 15

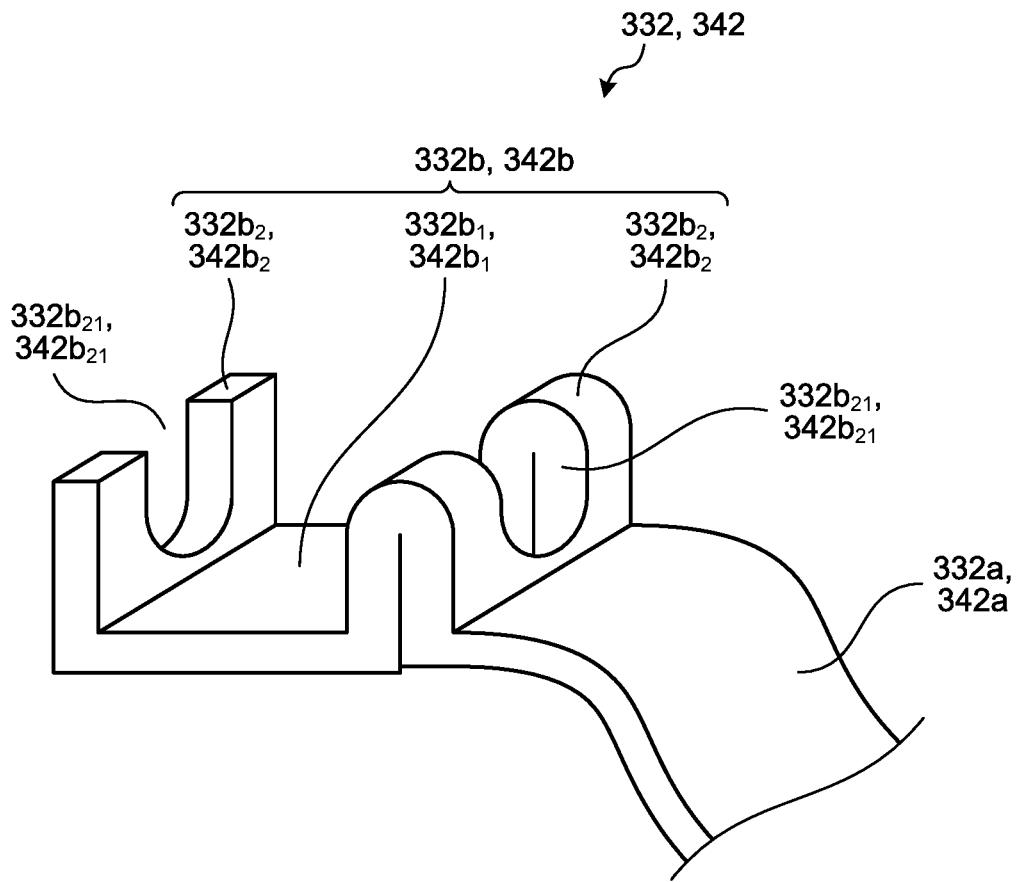


FIG. 16

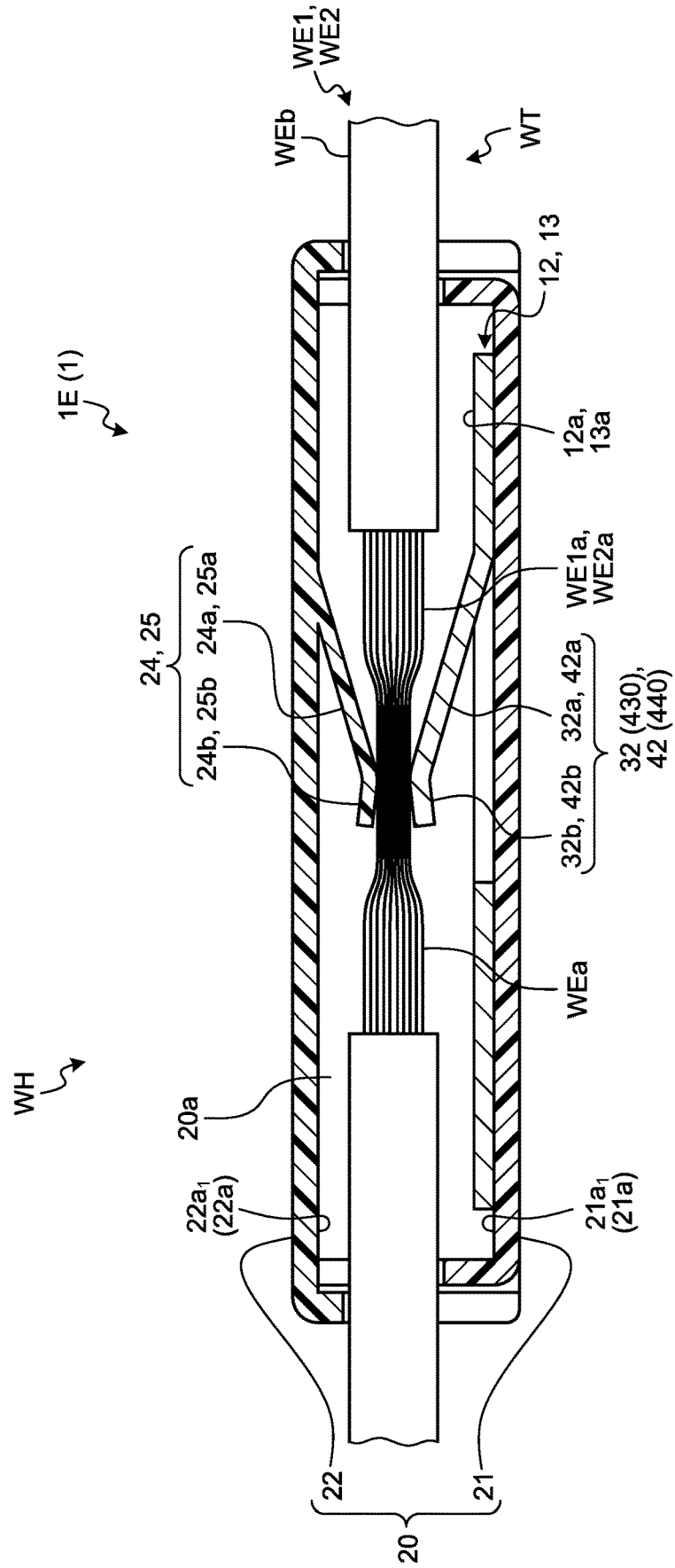


FIG. 17

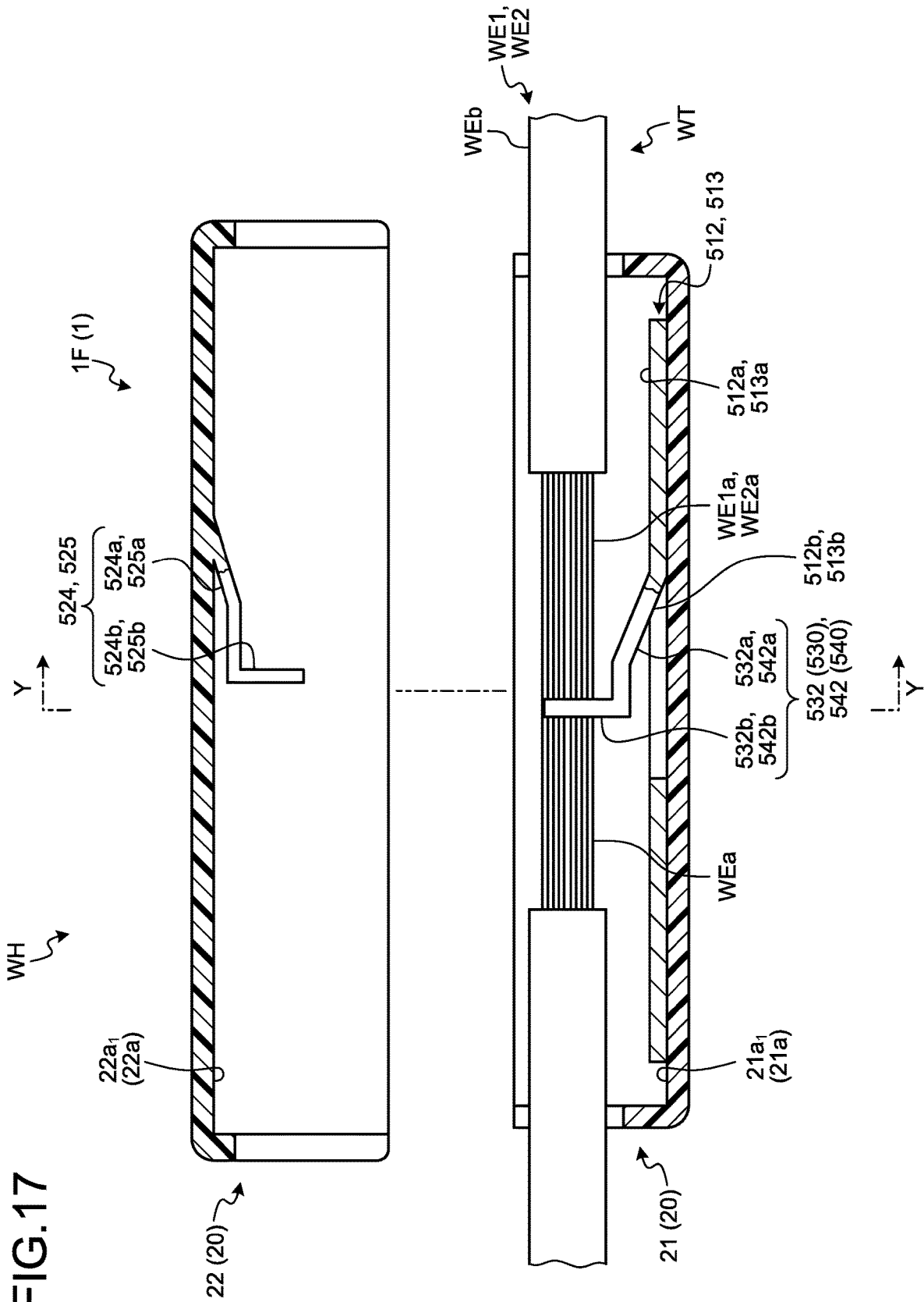


FIG. 19

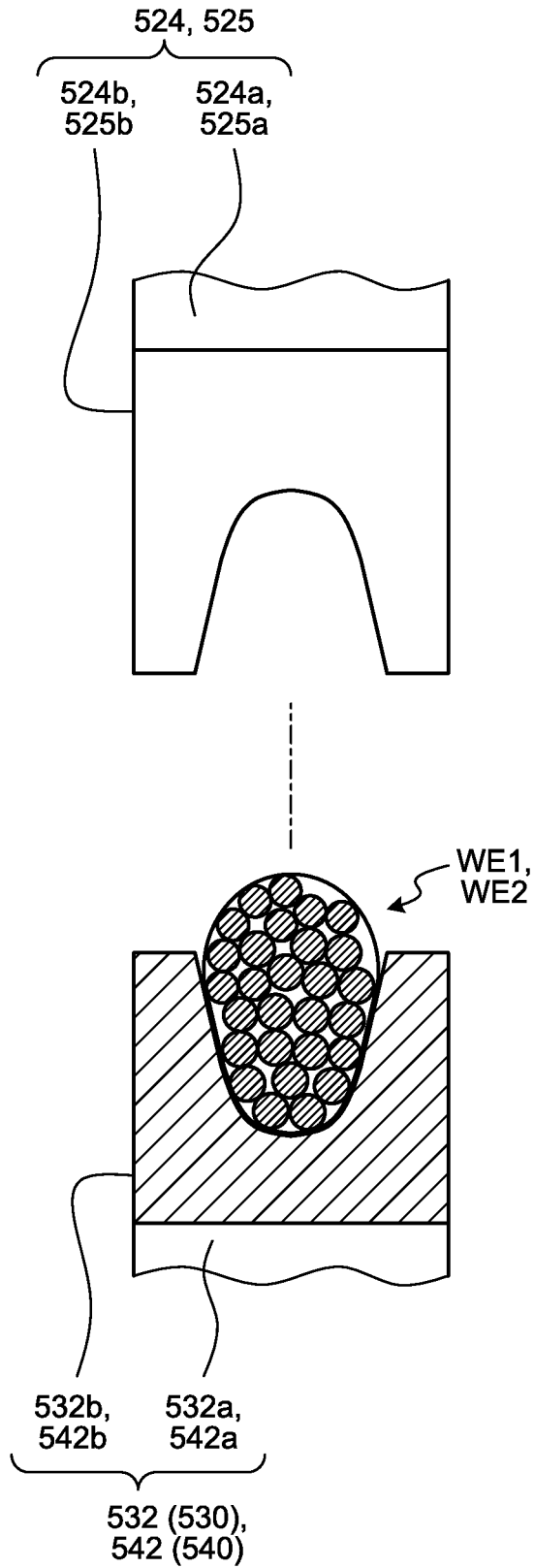
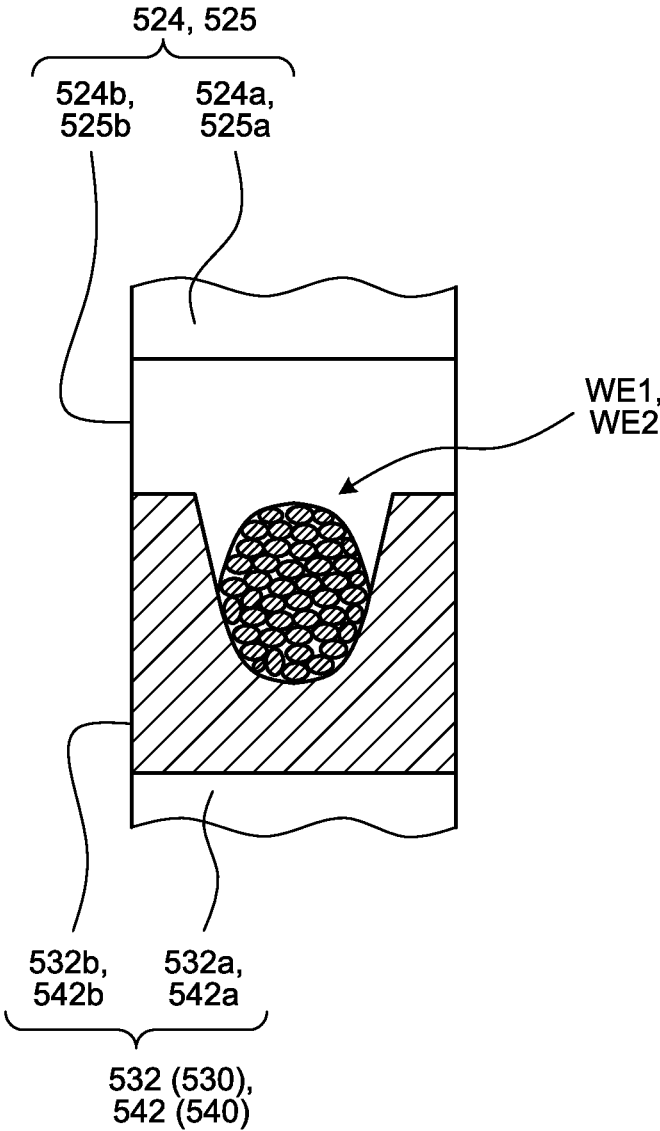


FIG.20



NOISE FILTER AND WIRE HARNESS**CROSS-REFERENCE TO RELATED APPLICATION(S)**

The present application claims priority to and incorporates by reference the entire contents of Japanese Patent Application No. 2018-127818 filed in Japan on Jul. 4, 2018.

BACKGROUND OF THE INVENTION**1. Field of the Invention**

The present invention relates to a noise filter and a wire harness.

2. Description of the Related Art

Conventionally, there has been a known technology for placing a noise filter on a noise reduction target electric wire to reduce electric noise on the electric wire. The noise filter includes a filter circuit provided with a noise reduction element such as a capacitor, and the filter circuit is interposed between the noise reduction target electric wire and a ground terminal. This type of noise filter is disclosed in, for example, Japanese Patent Application Laid-open No. 2012-039201.

Incidentally, in the conventional noise filter, the other terminal fitting crimped to a terminal of an electric wire such as a noise reduction target electric wire is connected to a terminal fitting installed on the filter circuit side. Each of the terminal fitting and the other terminal fitting includes a terminal portion, and the filter circuit and the electric wire are electrically connected to each other by inserting and fitting one female terminal portion and the other male terminal portion to each other. A connection structure of the terminal fitting and the other terminal fitting needs to have a mechanism for keeping a mutual fitting state, and there is a limit on a reduction in size thereof. Therefore, the conventional noise filter has room for improvement in attempting a reduction in size of a frame.

SUMMARY OF THE INVENTION

Therefore, an object of the invention is to provide a noise filter and a wire harness capable of attempting a reduction in size of a frame.

In order to achieve the above mentioned object, a noise filter according to one aspect of the present invention includes a filter circuit including a noise reduction element that reduces a noise component, a conductive first circuit connection member to which a first connection portion of the noise reduction element is electrically connected, and a conductive second circuit connection member to which a second connection portion of the noise reduction element is electrically connected; and an electric connection structure that electrically connects an intermediate connection portion of a core wire of an electric wire to one of the first circuit connection member and the second circuit connection member, wherein the electric connection structure includes a circuit side connection body provided in one of the first circuit connection member and the second circuit connection member and indirectly or directly electrically connected to the intermediate connection portion of the core wire of the electric wire by an elastic force indirectly or directly exerted on the intermediate connection portion of the core wire of the electric wire.

According to another aspect of the present invention, in the noise filter, it is desirable to further include a housing that accommodates the filter circuit, the intermediate connection portion of the core wire of the electric wire, and the electric connection structure, wherein the housing has a clamping body that indirectly or directly clamps the intermediate connection portion of the core wire of the electric wire between the circuit side connection body and the clamping body.

According to still another aspect of the present invention, in the noise filter, it is desirable that the electric connection structure includes an electric wire side connection body physically and electrically connected to the intermediate connection portion of the core wire of the electric wire, and the circuit side connection body is formed to be indirectly electrically connected to the intermediate connection portion of the core wire of the electric wire by an elastic force exerted on the electric wire side connection body.

According to still another aspect of the present invention, in the noise filter, it is desirable that the intermediate connection portion of the core wire of the electric wire is a part obtained by collectively fixing a plurality of strands forming the core wire of the electric wire, and the circuit side connection body is formed to be directly electrically connected to the intermediate connection portion by an elastic force exerted on the intermediate connection portion of the core wire of the electric wire.

In order to achieve the above mentioned object, a wire harness according to still another aspect of the present invention includes a trunk line including an electric wire; and a noise filter that reduces a noise component, wherein the noise filter includes a filter circuit including a noise reduction element that reduces a noise component, a conductive first circuit connection member to which a first connection portion of the noise reduction element is electrically connected, and a conductive second circuit connection member to which a second connection portion of the noise reduction element is electrically connected, and an electric connection structure that electrically connects an intermediate connection portion of a core wire of the electric wire to one of the first circuit connection member and the second circuit connection member, and the electric connection structure includes a circuit side connection body provided in one of the first circuit connection member and the second circuit connection member and indirectly or directly electrically connected to the intermediate connection portion of the core wire of the electric wire by an elastic force indirectly or directly exerted on the intermediate connection portion of the core wire of the electric wire.

The above and other objects, features, advantages and technical and industrial significance of this invention will be better understood by reading the following detailed description of presently preferred embodiments of the invention, when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view illustrating a noise filter and a wire harness of an embodiment;

FIG. 2 is an exploded perspective view illustrating the noise filter and the wire harness of the embodiment;

FIG. 3 is an exploded perspective view of the noise filter and the wire harness of the embodiment as viewed from a different angle;

FIG. 4 is a perspective view illustrating a filter circuit of the noise filter of the embodiment;

FIG. 5 is a cross-sectional view schematically illustrating a cross section taken along X1-X1 line and a cross section taken along X2-X2 line of FIG. 1;

FIG. 6 is a cross-sectional view illustrating a part of an assembling process of the noise filter and the wire harness of the embodiment;

FIG. 7 is a conceptual diagram of a filter circuit characteristic of the noise filter of the embodiment;

FIG. 8 is an exploded perspective view illustrating a first modification of the noise filter and the wire harness of the embodiment;

FIG. 9 is a perspective view illustrating the first modification of the noise filter and the wire harness of the embodiment;

FIG. 10 is a perspective view illustrating a second housing member of the first modification;

FIG. 11 is an exploded perspective view illustrating a second modification of the noise filter and the wire harness of the embodiment;

FIG. 12 is a perspective view illustrating the second modification of the noise filter and the wire harness of the embodiment;

FIG. 13 is a perspective view illustrating a third modification of the noise filter and the wire harness of the embodiment;

FIG. 14 is a perspective view illustrating a fourth modification of the noise filter and the wire harness of the embodiment;

FIG. 15 is a perspective view illustrating first and second circuit connection bodies of the fourth modification;

FIG. 16 is a perspective view illustrating a fifth modification of the noise filter and the wire harness of the embodiment;

FIG. 17 is an exploded perspective view illustrating a sixth modification of the noise filter and the wire harness of the embodiment;

FIG. 18 is a perspective view illustrating the sixth modification of the noise filter and the wire harness of the embodiment;

FIG. 19 is a cross-sectional view taken along Y-Y line of FIG. 17; and

FIG. 20 is a cross-sectional view taken along Y-Y line of FIG. 18.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, an embodiment of a noise filter and a wire harness according to the invention will be described in detail based on drawings. The invention is not limited by this embodiment.

Embodiment

One embodiment of the noise filter and the wire harness according to the invention will be described based on FIG. 1 to FIG. 20.

Reference symbol 1 of FIG. 1 to FIG. 3 denotes the noise filter of the present embodiment. The noise filter 1 is a noise reduction device in which intermediate portions of two electric wires (first electric wire WE1 and second electric wire WE2) are connected by a filter circuit. One of the two electric wires is grounded, and an electric noise component on the other electric wire is reduced by the filter circuit. For example, the two electric wires correspond to two of a plurality of electric wires included in a trunk line WT of a wire harness WH of a vehicle. One electric wire is grounded

as an earth wire, and the other electric wire is used as a power supply wire. For example, a load such as a defogger or a high mount stop lamp is electrically connected to the power supply line. The noise filter 1 becomes one component of the wire harness WH by being connected to the two electric wires. In the wire harness WH illustrated below, a first electric wire WE1 is used as a power supply wire, and a second electric wire WE2 is used as an earth wire. One end of the first electric wire WE1 is electrically connected to a power supply (for example, a secondary battery of the vehicle), and the other end thereof is electrically connected to the load. Further, one end of the second electric wire WE2 is grounded. Each of the first electric wire WE1 and the second electric wire WE2 includes a conductive core wire WEa and an insulating coating WEB covering an outer peripheral surface of the core wire WEa.

Noise Filter 1A

In the following, a noise filter 1A as an example of the noise filter 1 will be described (FIG. 1 to FIG. 3).

The noise filter 1A is a noise reduction device including a filter circuit 10 that reduces a noise component (FIG. 1 to FIG. 3). For example, the filter circuit 10 reduces an electrical noise component on the first electric wire WE1.

The filter circuit 10 is interposed between a portion of the core wire WEa located in an intermediate portion of the first electric wire WE1 and a portion of the core wire WEa located in an intermediate portion of the second electric wire WE2, and is electrically connected to each core wire WEa. Hereinafter, the portion of the core wire WEa located in the intermediate portion of the first electric wire WE1 will be referred to as an "intermediate connection portion WE1a", and the portion of the core wire WEa located in the intermediate portion of the second electric wire WE2 will be referred to as an "intermediate connection portion WE2a". In addition, in the following, the intermediate connection portion WE1a of the core wire WEa of the first electric wire WE1 will be simplified as the "intermediate connection portion WE1a of the first electric wire WE1", and the intermediate connection portion WE2a of the core wire WEa of the second electric wire WE2 will be simplified as the "intermediate connection portion WE2a of the second electric wire WE2".

The filter circuit 10 is interposed between the intermediate connection portion WE1a of the first electric wire WE1 and the intermediate connection portion WE2a of the second electric wire WE2 and is electrically connected to the respective intermediate connection portions WE1a and WE2a (FIG. 1).

The filter circuit 10 includes at least one noise reduction element 11 for reducing a noise component, a conductive first connection member (hereinafter referred to as a "first circuit connection member") 12 to which a first connection portion (hereinafter referred to as a "first element connection portion") of the noise reduction element 11 is electrically connected, and a conductive second connection member (hereinafter referred to as a "second circuit connection member") 13 to which a second connection portion (hereinafter referred to as a "second element connection portion") of the noise reduction element 11 is electrically connected (FIG. 1 to FIG. 3). Illustration of the first element connection portion and the second element connection portion is omitted.

Any noise reduction element 11 may be used as long as noise reduction can be achieved by this circuit configuration of the noise filter 1A. For example, as the noise reduction element 11, a capacitor, a coil, etc. can be considered. In this filter circuit 10, two capacitors are provided as the noise

reduction element **11**, and these two capacitors are configured to be able to reduce noise (FIG. 1 to FIG. 3).

The first circuit connection member **12** and the second circuit connection member **13** are conductive members that electrically connect each other through the noise reduction element **11**. Each of the first circuit connection member **12** and second circuit connection member **13** in this example is molded as a plate-shaped bus bar using a conductive material such as metal.

The first circuit connection member **12** and the second circuit connection member **13** have flat plate-shaped main bodies **12a** and **13a**, respectively (FIG. 1 to FIG. 3). In the filter circuit **10**, the first circuit connection member **12** and the second circuit connection member **13** are arranged side by side so that the main bodies **12a** and **13a** are disposed on the same plane. Further, in the filter circuit **10**, the first element connection portion of the noise reduction element **11** is physically and electrically connected to the main body **12a** of the first circuit connection member **12**, and the second element connection portion of the noise reduction element **11** is physically and electrically connected to the main body **13a** of the second circuit connection member **13**. As a connection form, for example, welding, soldering, etc. is applied in accordance with a form of the first element connection portion or the second element connection portion of the noise reduction element **11**.

The first circuit connection member **12** has a first circuit side connection body **12b** which is indirectly electrically connected to the intermediate connection portion WE1a of the first electric wire WE1 (FIG. 1 to FIG. 3). The first circuit side connection body **12b** is a component of a first electric connection structure **30** as described below. In addition, the second circuit connection member **13** has a second circuit side connection body **13b** which is indirectly electrically connected to the intermediate connection portion WE2a of the second electric wire WE2 (FIG. 1 to FIG. 3). The second circuit side connection body **13b** is a component of a second electric connection structure **40** as described below.

In the filter circuit **10** of this example, the two noise reduction elements **11** are covered with an insulating mold body **14** (FIG. 1 to FIG. 3). The mold body **14** is a solidified material of a molding agent injected between the two noise reduction elements **11** and the main body **12a** of the first circuit connection member **12** and the main body **13a** of the second circuit connection member **13**, and covers a connection part between the two noise reduction elements **11** and main body **12a** and a connection part between the two noise reduction elements **11** and the main body **13a**.

Further, the noise filter **1A** accommodates the filter circuit **10**, the intermediate connection portion WE1a of the first electric wire WE1, and the intermediate connection portion WE2a of the second electric wire WE2 in an inner accommodation chamber **20a** (FIG. 1), and includes a housing **20** that draws the respective end sides of the first electric wire WE1 outward from the inner accommodation chamber **20a** and draws the respective end sides of the second electric wire WE2 outward from the inner accommodation chamber **20a** (FIG. 1 to FIG. 3). The housing **20** is molded using an insulating material such as a synthetic resin. The housing **20** forms the accommodation chamber **20a** by fitting a first housing member **21** and a second housing member **22** to each other.

The first housing member **21** has a main wall body **21a** on which the filter circuit **10** is installed on an inner wall surface **21a₁**, and peripheral wall bodies **21b** to **21e** erected from a peripheral edge portion of the main wall body **21a** (FIG. 2). The first housing member **21** in this example has the

rectangular flat plate-shaped main wall body **21a** and the flat plate-shaped first to fourth peripheral wall bodies **21b** to **21e** suspended from four sides of the main wall body **21a**. The first housing member **21** has an opening **21f** including edges of the first to fourth peripheral wall bodies **21b** to **21e**.

The first circuit connection member **12** and the second circuit connection member **13** are installed on the inner wall surface **21a₁** side of the main wall body **21a** of the first housing member **21** (FIG. 1 and FIG. 2).

For example, the first circuit connection member **12** and the second circuit connection member **13** place wall surfaces of the main bodies **12a** and **13a**, respectively, on the inner wall surface **21a₁** of the main wall body **21a**, and fix the wall surfaces onto the inner wall surface **21a₁** using engaging mechanisms (not illustrated). For example, the engaging mechanism refers to a lock mechanism that holds the main body using a locking portion such as a claw provided at a plurality of positions on the inner wall surface **21a₁** of the main wall body **21a**. In addition, here, the first circuit connection member **12** and the second circuit connection member **13** may be installed on the inner wall surface **21a₁** side of the main wall body **21a** of the first housing member **21** by integrally molding the first housing member **21** with respect to the first circuit connection member **12** and the second circuit connection member **13**. In this case, in the main bodies **12a** and **13a** of the first circuit connection member **12** and the second circuit connection member **13**, the wall surfaces are exposed on the inner wall surface **21a₁** side of the main wall body **21a** of the first housing member **21**.

The second housing member **22** has a main wall body **22a** disposed to face the inner wall surface **21a₁** of the main wall body **21a** of the first housing member **21** at an interval, and blocks the opening of the first housing member **21**. The second housing member **22** in this example further has peripheral wall bodies **22b** to **22e** erected from a peripheral edge portion of the main wall body **22a** (FIG. 3). Here, the second housing member **22** has the rectangular flat plate-shaped main wall body **22a** and the flat plate-shaped first to fourth peripheral wall bodies **22b** to **22e** suspended from four sides of the main wall body **22a**, respectively. The second housing member **22** has an opening **22f** including edges of the first to fourth peripheral wall bodies **22b** to **22e**.

In the housing **20** in this example, the first peripheral wall bodies **21b** and **22b** of the first housing member **21** and the second housing member **22** are disposed to face each other, the second peripheral wall bodies **21c** and **22c** thereof are disposed to face each other, the third peripheral wall bodies **21d** and **22d** thereof are disposed to face each other, and the fourth peripheral wall bodies **21e** and **22e** thereof are disposed to face each other.

The housing **20** in this example accommodates the first electric wire WE1 and the second electric wire WE2 in the accommodation chamber **20a** in a parallel arrangement state, and causes the first electric wire WE1 and the second electric wire WE2 to run in parallel in the accommodation chamber **20a**. In the housing **20**, the first electric wire WE1 and the second electric wire WE2 are drawn outward from the first peripheral wall body **21b** and the second peripheral wall body **21c** in a facing arrangement state in the first housing member **21** and the first peripheral wall body **22b** and the second peripheral wall body **22c** in a facing arrangement state in the second housing member **22**.

The first peripheral wall bodies **21b** and **22b** of the first housing member **21** and the second housing member **22** have first outlets **21b₁** and **22b₁** for drawing out one end side of the first electric wire WE1 to the outside and second

outlets **21b₂** and **22b₂** for drawing out one end side of the second electric wire **WE2** to the outside, respectively (FIG. 2 and FIG. 3). In the respective first peripheral wall bodies **21b** and **22b**, the first outlets **21b₁** and **22b₁** are disposed to face each other, and the second outlets **21b₂** and **22b₂** are disposed to face each other.

The second peripheral wall bodies **21c** and **22c** of the first housing member **21** and the second housing member **22** have third outlets **21c₁** and **22c₁** for drawing out the other end side of the first electric wire **WE1** to the outside and fourth outlets **21c₂** and **22c₂** for drawing out the other end side of the second electric wire **WE2** to the outside, respectively (FIG. 2 and FIG. 3). In the respective second peripheral wall bodies **21c** and **22c**, the third outlets **21c₁** and **22c₁** are disposed to face each other, and the fourth outlets **21c₂** and **22c₂** are disposed to face each other.

The housing **20** in this example has a holding body **23** for holding with respect to an installation object of the noise filter **1A** (FIG. 3). The holding body **23** causes the installation object to hold the housing **20** by engaging with a counterpart holding body (not illustrated) of the installation object. Here, the holding body **23** is provided on an outer wall surface of the main wall body **21a** of the first housing member **21**.

Furthermore, the noise filter **1A** includes a first electric connection structure **30** for electrically connecting the intermediate connection portion **WE1a** of the first electric wire **WE1** to the first circuit connection member **12** of the filter circuit **10**, and a second electric connection structure **40** for electrically connecting the intermediate connection portion **WE2a** of the second electric wire **WE2** to the second circuit connection member **13** of the filter circuit **10** (FIG. 1 to FIG. 3). The first electric connection structure **30** and the second electric connection structure **40** are stored in the accommodation chamber **20a** of the housing **20**.

The first electric connection structure **30** performs mutual connection such that an axial direction of the first electric wire **WE1** extends along a plane of the main body **12a** of the first circuit connection member **12**. In addition, the second electric connection structure **40** performs mutual connection such that an axial direction of the second electric wire **WE2** extends along a plane of the main body **13a** of the second circuit connection member **13**. Further, the first electric connection structure **30** and the second electric connection structure **40** connect the first electric wire **WE1** and the first circuit connection member **12** to each other and connect the second electric wire **WE2** and the second circuit connection member **13** to each other such that the respective axial directions of the first electric wire **WE1** and the second electric wire **WE2** correspond to the same direction.

The first electric connection structure **30** includes a first electric wire side connection body **31** physically and electrically connected to the intermediate connection portion **WE1a** of the first electric wire **WE1**, and a first circuit side connection body **32** physically and electrically connected to the first electric wire side connection body **31** and the first circuit connection member **12** (FIG. 1 and FIG. 2).

The first electric wire side connection body **31** in this example is molded as one member (first electric wire side connection member) using a conductive material such as metal. For example, the first electric wire side connection body **31** is a tubular member physically and electrically connected to the intermediate connection portion **WE1a** of the

first electric wire **WE1**. The first electric wire side connection body **31** in this example is molded into a tubular shape (FIG. 1 and FIG. 2).

The first circuit side connection body **32** is formed to be indirectly electrically connected to the intermediate connection portion **WE1a** of the first electric wire **WE1**. The first circuit side connection body **32** in this example is indirectly electrically connected to the intermediate connection portion **WE1a** by an elastic force indirectly applied to the intermediate connection portion **WE1a** of the first electric wire **WE1**. Specifically, an elastic force is directly exerted on the first electric wire side connection body **31**, and the first circuit side connection body **32** is indirectly electrically connected to the intermediate connection portion **WE1a** of the first electric wire **WE1** by the elastic force exerted on the first electric wire side connection body **31**. The first circuit side connection body **32** is provided on the first circuit connection member **12**. The first circuit side connection body **32** may be molded as one member or included in a certain member as a part.

The former first circuit side connection body **32** is molded as a different member from the first circuit connection member **12**. The first circuit side connection body **32** is provided on the first circuit connection member **12** by being physically and electrically connected to the first circuit connection member **12** by welding, etc.

In addition, for example, the latter first circuit side connection body **32** is molded integrally with the main body **12a** of the first circuit connection member **12**, and is provided as a body included in the first circuit connection member **12**. This first electric connection structure **30** in this example includes this latter first circuit side connection body **32** (FIG. 1 to FIG. 3). Here, the first circuit side connection body **12b** of the first circuit connection member **12** is used as the first circuit side connection body **32** of the first electric connection structure **30**.

The first circuit side connection body **32** (**12b**) includes a piece (hereinafter referred to as an "elastic piece") **32a** having elasticity and a single body shape of a cantilever whose free end side is raised from the main body **12a** of the first circuit connection member **12**, and a contact portion **32b** provided at a free end of the elastic piece **32a** and directly electrically connected to the first electric wire side connection body **31** (FIG. 4 to FIG. 6). The first circuit side connection body **32** is physically and electrically connected to the first electric wire side connection body **31** by generating an elastic force using the elastic piece **32a** and causing the elastic force to directly act on the first electric wire side connection body **31** from the contact portion **32b**. Therefore, the first circuit side connection body **32** can be indirectly electrically connected to the intermediate connection portion **WE1a** of the first electric wire **WE1** via the first electric wire side connection body **31**.

The second electric connection structure **40** includes a second electric wire side connection body **41** physically and electrically connected to the intermediate connection portion **WE2a** of the second electric wire **WE2**, and a second circuit side connection body **42** physically and electrically connected to the second electric wire side connection body **41** and the second circuit connection member **13** (FIG. 1 to FIG. 3).

The second electric wire side connection body **41** in this example is a tubular member having the same tubular shape as that of the first electric wire side connection body **31**, and is physically and electrically connected to the intermediate connection portion **WE2a** by performing caulking while

winding a rectangular metal plate around the intermediate connection portion WE2a of the second electric wire WE2 (FIG. 1 to FIG. 3).

The second circuit side connection body 42 is formed to be indirectly electrically connected to the intermediate connection portion WE2a of the second electric wire WE2. The second circuit side connection body 42 in this example is indirectly electrically connected to the intermediate connection portion WE2a by an elastic force indirectly applied to the intermediate connection portion WE2a of the second electric wire WE2. Specifically, an elastic force is directly exerted on the second electric wire side connection body 41, and the second circuit side connection body 42 is indirectly electrically connected to the intermediate connection portion WE2a of the second electric wire WE2 by the elastic force exerted on the second electric wire side connection body 41. The second circuit side connection body 42 is provided on the second circuit connection member 13. Similarly to the first circuit side connection body 32, the second circuit side connection body 42 may be molded as one member or included in a certain member as a part. The second circuit side connection body 42 in this example is molded integrally with the main body 13a of the second circuit connection member 13, and is provided as a body included in the second circuit connection member 13. Here, the second circuit side connection body 13b of the second circuit connection member 13 is used as the second circuit side connection body 42 of the second electric connection structure 40.

The second circuit side connection body 42 (13b) is formed in the same shape as that of the first circuit side connection body 32 (12b). Therefore, the second circuit side connection body 42 includes a piece (hereinafter referred to as an “elastic piece”) 42a having elasticity and a single body shape of a cantilever whose free end side is raised from the main body 13a of the second circuit connection member 13, and a contact portion 42b provided at a free end of the elastic piece 42a and directly electrically connected to the second electric wire side connection body 41 (FIG. 4 to FIG. 6). The second circuit side connection body 42 is physically and electrically connected to the second electric wire side connection body 41 by generating an elastic force using the elastic piece 42a and causing the elastic force to directly act on the second electric wire side connection body 41 from the contact portion 42b. Therefore, the second circuit side connection body 42 can be indirectly electrically connected to the intermediate connection portion WE2a of the second electric wire WE2 via the second electric wire side connection body 41.

Here, the elastic force of the first circuit side connection body 32 is generated by clamping the first circuit connection member 12 and the first electric wire side connection body 31 between the inner wall surface 21a₁ side of the main wall body 21a of the first housing member 21 and an inner wall surface 22a₁ side of the main wall body 22a of the second housing member 22 when the first housing member 21 and the second housing member 22 are fit to each other (FIG. 5). Therefore, in the first electric connection structure 30, the first electric wire side connection body 31 and the first circuit side connection body 32 (the first circuit side connection body 12b of the first circuit connection member 12) are disposed to face each other in a fitting direction of the first housing member 21 and the second housing member 22.

In addition, the elastic force of the second circuit side connection body 42 is generated by clamping the second circuit connection member 13 and the second electric wire side connection body 41 between the inner wall surface 21a₁ side of the main wall body 21a of the first housing member

21 and the inner wall surface 22a₁ side of the main wall body 22a of the second housing member 22 when the first housing member 21 and the second housing member 22 are fit to each other (FIG. 5). Therefore, in the second electric connection structure 40, the second electric wire side connection body 41 and the second circuit side connection body 42 (the second circuit side connection body 13b of the second circuit connection member 13) are disposed to face each other in the fitting direction of the first housing member 21 and the second housing member 22.

In this noise filter 1A, to generate an elastic force in the first circuit side connection body 32 and the second circuit side connection body 42, the first electric wire side connection body 31 is clamped by the contact portion 32b of the first circuit side connection body 32 and the inner wall surface 22a₁ side of the main wall body 22a of the second housing member 22, and the second electric wire side connection body 41 is clamped by the contact portion 42b of the second circuit side connection body 42 and the inner wall surface 22a₁ side of the main wall body 22a of the second housing member 22 in the fitting direction of the first housing member 21 and the second housing member 22 (FIG. 5). That is, here, the fitting direction of the first housing member 21 and the second housing member 22 corresponds to a clamping direction (hereinafter referred to as an “electric wire clamping direction”) with respect to the first electric wire side connection body 31 and the second electric wire side connection body 41.

At least one first clamping body 24 that indirectly clamps the intermediate connection portion WE1a of the first electric wire WE1 between the contact portion 32b of the first circuit side connection body 32 and the inner wall surface 22a₁, and at least one second clamping body 25 that indirectly clamps the intermediate connection portion WE2a of the second electric wire WE2 between the contact portion 42b of the second circuit side connection body 42 and the inner wall surface 22a₁ are provided on the inner wall surface 22a₁ of the main wall body 22a of the second housing member 22 (FIG. 3, FIG. 5, and FIG. 6).

The first clamping body 24 indirectly clamps the intermediate connection portion WE1a of the first electric wire WE1 between the contact portion 32b and the first clamping body 24 by clamping the first electric wire side connection body 31 between the contact portion 32b of the first circuit side connection body 32 and the first clamping body 24. The first clamping body 24 includes a piece 24a having a single body shape of a cantilever whose free end side is raised from the inner wall surface 22a₁ of the main wall body 22a of the second housing member 22 and a pressing portion 24b provided at a free end of the piece 24a to come into contact with and press the first electric wire side connection body 31 (FIG. 3, FIG. 5, and FIG. 6). The piece 24a may or may not have elasticity. In addition, the pressing portion 24b is disposed to face the contact portion 32b in the electric wire clamping direction. Here, the pressing portion 24b and the contact portion 32b are formed in rectangular single body shapes, respectively, and the first electric wire side connection body 31 is clamped between planes thereof.

The second clamping body 25 indirectly clamps the intermediate connection portion WE2a of the second electric wire WE2 between the contact portion 42b and the second clamping body 25 by clamping the second electric wire side connection body 41 between the contact portion 42b of the second circuit side connection body 42 and the second clamping body 25. The second clamping body 25 includes a piece 25a having a single body shape of a cantilever whose free end side is raised from the inner wall surface 22a₁ of the

main wall body **22a** of the second housing member **22** and a pressing portion **25b** provided at a free end of the piece **25a** to come into contact with and press the second electric wire side connection body **41** (FIG. 3, FIG. 5, and FIG. 6). The piece **25a** may or may not have elasticity. In addition, the pressing portion **25b** is disposed to face the contact portion **42b** in the electric wire clamping direction. Here, the pressing portion **25b** and the contact portion **42b** are formed in rectangular single body shapes, respectively, and the second electric wire side connection body **41** is clamped between planes thereof.

In the noise filter **1A**, in an inner space of the first housing member **21**, the first electric wire **WE1** is disposed in a state in which the first electric wire side connection body **31** is placed on the contact portion **32b**, and the second electric wire **WE2** is disposed in a state in which the second electric wire side connection body **41** is placed on the contact portion **42b** (FIG. 6). In the noise filter **1A**, the second housing member **22** is fit to the first housing member **21** (FIG. 6).

When the first housing member **21** and the second housing member **22** are fit to each other, a pressing force from the pressing portion **24b** to the contact portion **32b** acts on the first electric wire side connection body **31**, the first electric wire side connection body **31** pushes and moves the contact portion **32b**, and thus an elastic force of the elastic piece **32a** against a pushing force acts on the first electric wire side connection body **31** from the contact portion **32b**. In addition, when the first housing member **21** and the second housing member **22** are fit to each other, a pressing force from the pressing portion **25b** to the contact portion **42b** acts on the second electric wire side connection body **41**, the second electric wire side connection body **41** pushes and moves the contact portion **42b**, and thus an elastic force of the elastic piece **42a** against a pushing force acts on the second electric wire side connection body **41** from the contact portion **42b**. Therefore, in the noise filter **1A**, when the first housing member **21** and the second housing member **22** are fit to each other, the first electric wire side connection body **31** is clamped by the pressing portion **24b** and the contact portion **32b** so that the first electric wire side connection body **31** and the contact portion **32b** are physically and electrically connected to each other, and the second electric wire side connection body **41** is clamped by the pressing portion **25b** and the contact portion **42b** so that the second electric wire side connection body **41** and the contact portion **42b** are physically and electrically connected to each other. Therefore, in the noise filter **1A**, the intermediate connection portion **WE1a** of the first electric wire **WE1** and the first circuit connection member **12** of the filter circuit **10** are indirectly electrically connected via the first electric wire side connection body **31**, and the intermediate connection portion **WE2a** of the second electric wire **WE2** and the second circuit connection member **13** of the filter circuit **10** are indirectly electrically connected via the second electric wire side connection body **41**.

Incidentally, as in Japanese Patent Application Laid-open No. 2012-039201 described above, in the conventional noise filter, an intermediate electric wire is interposed between the noise reduction target electric wire and the filter circuit. The intermediate electric wire has a large allowable tolerance regarding a length in consideration of assembling workability with respect to the noise filter, a wiring route to a vehicle, etc. For this reason, the conventional noise filter needs to adjust a filter circuit characteristic (resonance point, noise reduction performance, etc.) taking the noise component of the intermediate electric wire according to the length thereof

into consideration. However, in the noise filter **1A**, the filter circuit **10** is interposed between the intermediate connection portion **WE1a** of the first electric wire **WE1** and the intermediate connection portion **WE2a** of the second electric wire **WE2** bundled in the trunk line **WT** of the wire harness **WH**, and the filter circuit **10** is electrically connected to the respective intermediate connection portions **WE1a** and **WE2a**. Therefore, this noise filter **1A** may not adjust a filter circuit characteristic taking an influence of a branched electric wire (intermediate electric wire) from the trunk line into consideration unlike the past. That is, the noise filter **1A** is not affected by the intermediate electric wire.

FIG. 7 illustrates a conceptual diagram of a filter circuit characteristic in which a horizontal axis depicts a frequency and a vertical axis depicts a noise reduction level. In this figure, a required performance of noise reduction is indicated by a broken line, the filter circuit characteristic of the noise filter **1A** of the present embodiment is indicated by a solid line, and the filter circuit characteristic of the conventional noise filter is indicated by an alternate long and two short dashes line.

For example, the noise filter **1A** may be wrapped in an adhesive tape, etc. together with the trunk line **WT**, and held by the trunk line **WT**.

Furthermore, since the noise filter **1A** electrically connects the filter circuit **10** to the intermediate connection portion **WE2a** of the second electric wire **WE2** whose one end is grounded, for example, even when a conductor that can be grounded is not present around the trunk line **WT**, and even when an installation object is molded using an insulating material such as a synthetic resin, it is possible to easily perform grounding. That is, when the conventional noise filter is attached to a conductive installation object, the conventional noise filter is grounded through the installation object by connecting a ground terminal to the installation object. Therefore, in the conventional noise filter, the ground terminal is projected from the housing to facilitate a fixing operation of the ground terminal and the installation object. However, this noise filter **1A** can be grounded without such a ground terminal. Therefore, the noise filter **1A** can achieve reduction in size and weight of a frame.

Furthermore, in the noise filter **1A**, an electric connection structure between the intermediate connection portion **WE1a** of the first electric wire **WE1** and the first circuit side connection body **32** and an electric connection structure between the intermediate connection portion **WE2a** of the second electric wire **WE2** and the second circuit side connection body **42** utilize an elastic force of each of the first circuit side connection body **32** and the second circuit side connection body **42**. Therefore, when compared to a case in which a connection structure corresponds to a fitting structure of male and female terminal portions as in the past, the noise filter **1A** can achieve reduction in size of each connection structure. Therefore, the noise filter **1A** can achieve reduction in size of the frame. In addition, even though such a conventional connection structure may cause a steep rise in cost depending on the shape, since the noise filter **1A** corresponds to a connection structure utilizing an elastic force, it is possible to simplify the structure and suppress the steep rise in cost.

Furthermore, this noise filter **1A** can absorb a dimensional variation of each component and exert a stable contact load on the respective intermediate connection portions **WE1a** and **WE2a** by adopting such a connection structure based on the elastic force. In addition, even when the dimensional variation of each component further increases, the noise filter **1A** can absorb the dimensional variation and apply a

stable contact load to each intermediate connection portion WE2a by assigning elasticity to the piece 24a of the first clamping body 24 and the piece 25a of the second clamping body 25 in cooperation with elasticity of the first circuit side connection body 32 and the second circuit side connection body 42. Due to such a characteristic, the noise filter 1A can improve a quality of conduction between the first electric wire WE1 and the second electric wire WE2, and the filter circuit 10.

Furthermore, by adopting a connection structure based on an elastic force, the noise filter 1A can attempt electric connection to electric wires having various outer diameters (the first electric wire WE1 and the second electric wire WE2) within a range of an elastic region of the first circuit side connection body 32 and the second circuit side connection body 42. In addition, when elasticity is assigned to the piece 24a of the first clamping body 24 and the piece 25a of the second clamping body 25, the noise filter 1A can attempt electric connection to electric wires having various outer diameters (the first electric wire WE1 and the second electric wire WE2) within a range of an elastic region including the elasticities thereof. That is, the noise filter 1A can cope with electric wires having various outer diameters (the first electric wire WE1 and the second electric wire WE2), and versatility can be enhanced.

Noise Filter 1B

Here, the noise filter 1 of the present embodiment may be configured as a noise filter 1B in which a first clamping body 124 and a second clamping body 125 described below are provided in a second housing member 122 in place of the second housing member 22 having the first clamping body 24 and the second clamping body 25 described above (FIG. 8 and FIG. 9). This noise filter 1B can obtain a similar effect to that of the above-mentioned noise filter 1A, and can obtain an effect described below by the first clamping body 124 and the second clamping body 125.

The second housing member 122 is a housing member in which the first clamping body 24 is replaced with the first clamping body 124 and the second clamping body 25 is replaced with the second clamping body 125 in the second housing member 22 described above. The second housing member 122 is included in a housing 120 in which an accommodation chamber 120a is formed inward by being fit to the first housing member 21 described above (FIG. 9). Two first clamping bodies 124 and two second clamping bodies 125 are provided on an inner wall surface 122a₁ of a main wall body 122a of the second housing member 122 (FIG. 8 and FIG. 9).

In addition to a piece 124a and a pressing portion 124b similar to those of the first clamping body 24 described above, the first clamping body 124 has a locking projection 124c bulged out from the pressing portion 124b (FIG. 8 to FIG. 10). In addition, in addition to a piece 125a and a pressing portion 125b similar to those of the second clamping body 25 described above, the second clamping body 125 has a locking projection 125c bulged out from the pressing portion 125b (FIG. 8 to FIG. 10).

In the noise filter 1B, the first electric wire side connection body 31 is clamped by the pressing portion 124b and the contact portion 32b of each of the two first clamping bodies 124, and the second electric wire side connection body 41 is clamped by the pressing portion 125b and the contact portion 42b of each of the two second clamping bodies 125 (FIG. 8 and FIG. 9). In this instance, the contact portion 32b may be disposed to face only the pressing portion 124b of one of the first clamping bodies 124 in the electric wire clamping direction or disposed to face the respective press-

ing portions 124b of both the first clamping bodies 124 in the electric wire clamping direction. Similarly thereto, the contact portion 42b may be disposed to face only the pressing portion 125b of one of the second clamping bodies 125 in the electric wire clamping direction or disposed to face the respective pressing portions 125b of both the second clamping bodies 125 in the electric wire clamping direction.

In addition, the locking projection 124c of one of the first clamping bodies 124 is formed to lock one end of the first electric wire side connection body 31 in a tube axis direction in the tube axis direction (FIG. 9). Further, the locking projection 124c of the other one of the first clamping bodies 124 is formed to lock the other end of the first electric wire side connection body 31 in the tube axis direction in the tube axis direction (FIG. 9). That is, in the noise filter 1B, the first electric wire side connection body 31 is clamped from both ends in the tube axis direction using two locking projections 124c. Further, the locking projection 125c of one of the second clamping bodies 125 is formed to lock one end of the second electric wire side connection body 41 in the tube axis direction in the tube axis direction (FIG. 9). Further, the locking projection 125c of the other one of the second clamping bodies 125 is formed to lock the other end of the second electric wire side connection body 41 in the tube axis direction in the tube axis direction (FIG. 9). That is, in the noise filter 1B, the second electric wire side connection body 41 is clamped from both ends in the tube axis direction using two locking projections 125c. In this way, in the noise filter 1B, the first electric wire side connection body 31, the first electric wire WE1, the second electric wire side connection body 41, and the second electric wire WE2 in the accommodation chamber 120a of the housing 120 can be positioned by the two locking projections 124c and the two locking projections 125c. Therefore, the noise filter 1B can further improve the quality of conduction between the first electric wire WE1 and the second electric wire WE2, and the filter circuit 10.

Noise Filter 1C

In addition, the noise filter 1 of the present embodiment may be configured as a noise filter 1C in which a first clamping body 224 and a second clamping body 225 described below are provided in a second housing member 222 in place of the second housing member 22 having the first clamping body 24 and the second clamping body 25 described above (FIG. 11 and FIG. 12). This noise filter 1C can obtain a similar effect to that of the above-mentioned noise filter 1A, and can obtain an effect described below by the first clamping body 224 and the second clamping body 225.

The second housing member 222 is a housing member in which the first clamping body 24 is replaced with the first clamping body 224 and the second clamping body 25 is replaced with the second clamping body 225 in the second housing member 22 described above. The second housing member 222 is included in a housing 220 in which an accommodation chamber 220a is formed inward by being fit to the first housing member 21 described above (FIG. 12). Two first clamping bodies 224 and two second clamping bodies 225 are provided on an inner wall surface 222a₁ of a main wall body 222a of the second housing member 222 (FIG. 11 and FIG. 12).

The first clamping body 224 has a pressing portion 224b bulged out from the inner wall surface 222a₁ of the main wall body 222a to come into contact with and press the first electric wire side connection body 31, and a locking projection 224c bulged out from the inner wall surface 222a₁ (FIG. 11 and FIG. 12). In addition, the second clamping

body 225 has a pressing portion 225b bulged out from the inner wall surface 222a, of the main wall body 222a to come into contact with and press the second electric wire side connection body 41, and a locking projection 225c bulged out from the inner wall surface 222a, (FIG. 11 and FIG. 12).

In the noise filter 1C, the first electric wire side connection body 31 is clamped by the pressing portion 224b and the contact portion 32b of each of the two first clamping bodies 224, and the second electric wire side connection body 41 is clamped by the pressing portion 225b and the contact portion 42b of each of the two second clamping bodies 225. In this instance, the contact portion 32b may be disposed to face only the pressing portion 224b of one of the first clamping bodies 224 in the electric wire clamping direction or disposed to face the respective pressing portions 224b of both the first clamping bodies 224 in the electric wire clamping direction. Similarly thereto, the contact portion 42b may be disposed to face only the pressing portion 225b of one of the second clamping bodies 225 in the electric wire clamping direction or disposed to face the respective pressing portions 225b of both the second clamping bodies 225 in the electric wire clamping direction.

In addition, the locking projection 224c of one of the first clamping bodies 224 is formed to lock one end of the first electric wire side connection body 31 in the tube axis direction in the tube axis direction (FIG. 12). Further, the locking projection 224c of the other one of the first clamping bodies 224 is formed to lock the other end of the first electric wire side connection body 31 in the tube axis direction in the tube axis direction (FIG. 12). That is, in the noise filter 1C, the first electric wire side connection body 31 is clamped from both ends in the tube axis direction using two locking projections 224c. Further, the locking projection 225c of one of the second clamping bodies 225 is formed to lock one end of the second electric wire side connection body 41 in the tube axis direction in the tube axis direction (FIG. 12). Further, the locking projection 225c of the other one of the second clamping bodies 225 is formed to lock the other end of the second electric wire side connection body 41 in the tube axis direction in the tube axis direction (FIG. 12). That is, in the noise filter 1C, the second electric wire side connection body 41 is clamped from both ends in the tube axis direction using two locking projections 225c. In this way, in the noise filter 1C, the first electric wire side connection body 31, the first electric wire WE1, the second electric wire side connection body 41, and the second electric wire WE2 in the accommodation chamber 220a of the housing 220 can be positioned by the two locking projections 224c and the two locking projections 225c. Therefore, the noise filter 1C can further improve the quality of conduction between the first electric wire WE1 and the second electric wire WE2, and the filter circuit 10.

Noise Filter 1D

The noise filter 1 of the present embodiment may be configured as a noise filter 1D in which a first electric connection structure 330 including a first circuit side connection body 332 and a second electric connection structure 340 including a second circuit side connection body 342 described below is provided in place of the first electric connection structure 30 including the first circuit side connection body 32 (12b) and the second electric connection structure 40 including the second circuit side connection body 42 (13b) described above (FIG. 13 and FIG. 14). This noise filter 1D can obtain a similar effect to that of the above-mentioned noise filter 1A, and can obtain an effect described below by the first circuit side connection body 332 and the second circuit side connection body 342.

As in the previous example, the first circuit side connection body 332 is provided on a first circuit connection member 312 including a main body 312a and a first circuit side connection body 312b, and uses the first circuit side connection body 312b (FIG. 13 and FIG. 14). The first circuit side connection body 332 has an elastic piece 332a similar to the first circuit side connection body 32 (12b) described above and has a contact portion 332b provided at a free end of the elastic piece 332a and directly electrically connected to the first electric wire side connection body 31 (FIG. 13 to FIG. 15). The contact portion 332b in this example has a rectangular piece 332b₁ similar to the contact portion 32b in contact with an outer peripheral surface of the first electric wire side connection body 31, and two locking projections 332b₂ projected from the piece 332b₁ to interpose both ends of the first electric wire side connection body 31 in the tube axis direction in the tube axis direction (FIG. 13 to FIG. 15). An arc-shaped notch 332b₂₁ into which the intermediate connection portion WE1a of the first electric wire WE1 is inserted is provided in each of the locking projections 332b₂ in this example (FIG. 15). The first circuit side connection body 332 forms the first electric connection structure 330 as a pair with the first electric wire side connection body 31 described above.

Similarly to the previous example, the second circuit side connection body 342 is provided on a second circuit connection member 313 having a main body 313a and a second circuit side connection body 313b, and uses the second circuit side connection body 313b (FIG. 13 and FIG. 14). The second circuit side connection body 342 has an elastic piece 342a similar to the second circuit side connection body 42 (13b) described above and has a contact portion 342b provided at a free end of the elastic piece 342a and directly electrically connected to the second electric wire side connection body 41 (FIG. 13 to FIG. 15). The contact portion 342b in this example has a rectangular piece 342b₁ similar to the contact portion 42b in contact with an outer peripheral surface of the second electric wire side connection body 41, and two locking projections 342b₂ projected from the piece 342b₁ to interpose both ends of the second electric wire side connection body 41 in the tube axis direction in the tube axis direction (FIG. 13 to FIG. 15). An arc-shaped notch 342b₂₁ into which the intermediate connection portion WE2a of the second electric wire WE2 is inserted is provided in each of the locking projections 342b₂ in this example (FIG. 15). The second circuit side connection body 342 forms the second electric connection structure 340 as a pair with the second electric wire side connection body 41 described above.

The noise filter 1D can position the first electric wire side connection body 31, the first electric wire WE1, the second electric wire side connection body 41, and the second electric wire WE2 in the accommodation chamber 20a of the housing 20 by the two locking projections 332b₂ and the two locking projections 342b₂. Therefore, the noise filter 1D can further improve the quality of conduction between the first electric wire WE1 and the second electric wire WE2, and the filter circuit 10.

Noise Filter 1E

The noise filter 1 of the present embodiment may be configured as a noise filter 1E in which a first electric connection structure 430 and a second electric connection structure 440 described below are provided in place of the first electric connection structure 30 and the second electric connection structure 40 described above (FIG. 16). This noise filter 1E can obtain a similar effect to that of the above-mentioned noise filter 1A, and can obtain an effect

described below by the first electric connection structure **430** and the second electric connection structure **440**.

The first electric connection structure **430** includes the first circuit side connection body **32** without having the first electric wire side connection body **31**. The first electric connection structure **430** clamps the intermediate connection portion **WE1a** of the first electric wire **WE1** by the pressing portion **24b** and the contact portion **32b** of the first circuit side connection body **32** in cooperation with the first clamping body **24** of the second housing member **22**.

That is, the first circuit side connection body **32** in this example is formed to be directly electrically connected to the intermediate connection portion **WE1a** of the first electric wire **WE1**. The first circuit side connection body **32** is directly electrically connected to the intermediate connection portion **WE1a** of the first electric wire **WE1** by an elastic force directly applied to the intermediate connection portion **WE1a**. Further, the first clamping body **24** in this example is formed to directly clamp the intermediate connection portion **WE1a** of the first electric wire **WE1** between the first clamping body **24** and the contact portion **32b** of the first circuit side connection body **32**.

In addition, the second electric connection structure **440** includes the second circuit side connection body **42** without the second electric wire side connection body **41**. The second electric connection structure **440** clamps the intermediate connection portion **WE2a** of the second electric wire **WE2** by the pressing portion **25b** and the contact portion **42b** of the second circuit side connection body **42** in cooperation with the second clamping body **25** of the second housing member **22**.

That is, the second circuit side connection body **42** in this example is formed to be directly electrically connected to the intermediate connection portion **WE2a** of the second electric wire **WE2**. The second circuit side connection body **42** is directly electrically connected to the intermediate connection portion **WE2a** of the second electric wire **WE2** by an elastic force directly applied to the intermediate connection portion **WE2a**. Further, the second clamping body **25** in this example is formed to directly clamp the intermediate connection portion **WE2a** of the second electric wire **WE2** between the second clamping body **25** and the contact portion **42b** of the second circuit side connection body **42**.

Here, it is desirable to use the noise filter **1E** in a case of applying the first electric wire **WE1** and the second electric wire **WE2** whose core wire **WEa** is a single wire such as a round conductor. A reason therefor is that in a case in which the core wire **WEa** is an aggregate obtained by bundling a plurality of strands in each of the intermediate connection portions **WE1a** and **WE2a**, the respective strands may be separated at the time of being clamped by the pressing portions **24b** and **25b** and the contact portions **32b** and **42b**, and thus it may not be possible to receive a pushing force from the pressing portions **24b** and **25b** and an elastic force from the contact portions **32b** and **42b**. That is, a reason therefor is that in a case in which the core wire **WEa** is an aggregate of a plurality of strands, an appropriate contact load may not be applied to each of the intermediate connection portions **WE1a** and **WE2a**, and there is a possibility that conduction between each of the intermediate connection portions **WE1a** and **WE2a** and the filter circuit **10** may not be smoothly performed. However, even when the core wire **WEa** is an aggregate of a plurality of strands, the first electric wire **WE1** and the second electric wire **WE2** can be applied to the noise filter **1E** without including the first electric wire side connection body **31** or the second electric wire side

connection body **41** by welding the plurality of strands in the intermediate connection portions **WE1a** and **WE2a** using thermo-compression bonding, etc. and fixing the plurality of strands collectively (FIG. **16**).

In this way, since the number of parts is reduced in the first electric connection structure **430** and the second electric connection structure **440**, the noise filter **1E** can attempt weight reduction, improvement in assembling workability, and cost reduction.

Noise Filter **1F**

The noise filter **1** of the present embodiment may be configured as a noise filter **1F** in which a second housing member **522** having a first clamping body **524** and a second clamping body **525**, a first electric connection structure **530**, and a second electric connection structure **540** described below are provided in place of the second housing member **22** having the first clamping body **24** and the second clamping body **25**, the first electric connection structure **30**, and the second electric connection structure **40** described above (FIG. **17** and FIG. **18**). This noise filter **1F** can obtain a similar effect to that of the above-mentioned noise filter **1A**, and can obtain an effect described below by the first clamping body **524**, the second clamping body **525**, the first electric connection structure **430**, and the second electric connection structure **440**.

The second housing member **522** is obtained by replacing the first clamping body **24** with the first clamping body **524** and replacing the second clamping body **25** with the second clamping body **525** in the second housing member **22** described above. The second housing member **522** is included in a housing **520** having an accommodation chamber **520a** formed inward by being fit to the first housing member **21** described above (FIG. **18**). At least one first clamping body **524** and at least one second clamping body **525** are provided on an inner wall surface **522a₁** of a main wall body **522a** of the second housing member **522** (FIG. **17** and FIG. **18**). Here, one first clamping body **524** and one second clamping body **525** are provided.

The first clamping body **524** has a piece **524a** similar to that of the first clamping body **24** described above, and has a pressing portion **524b** provided at a free end of the piece **524a** to come into contact with and press the intermediate connection portion **WE1a** of the first electric wire **WE1** (FIG. **17** and FIG. **18**). The pressing portion **524b** is formed in a U-shape. The pressing portion **524b** is open to a side of the intermediate connection portion **WE1a** of the first electric wire **WE1**, and inserts the intermediate connection portion **WE1a** inward from the opening. In addition, the second clamping body **525** has a piece **525a** similar to that of the second clamping body **25** described above, and has a pressing portion **525b** provided at a free end of the piece **525a** to come into contact with and press the intermediate connection portion **WE2a** of the second electric wire **WE2** (FIG. **17** and FIG. **18**). The pressing portion **525b** is formed in a U-shape (FIG. **19**). The pressing portion **525b** is open to a side of the intermediate connection portion **WE2a** of the second electric wire **WE2**, and inserts the intermediate connection portion **WE2a** inward from the opening.

The first electric connection structure **530** includes a first circuit side connection body **532** without having the first electric wire side connection body **31** described above (FIG. **17** and FIG. **18**). As in the previous example, the first circuit side connection body **532** is provided on a first circuit connection member **512** having a main body **512a** and a first circuit side connection body **512b**, and uses the first circuit side connection body **512b** (FIG. **17** and FIG. **18**). The first circuit side connection body **532** has an elastic piece **532a**

similar to that of the first circuit side connection body **32** (**12b**) described above, and has a contact portion **532b** provided at a free end of the elastic piece **532a** and directly electrically connected to the intermediate connection portion **WE1a** of the first electric wire **WE1** (FIG. 17 and FIG. 18). The contact portion **532b** in this example has a U-shape (FIG. 19). The contact portion **532b** is open to a side of the intermediate connection portion **WE1a** of the first electric wire **WE1**, and inserts the intermediate connection portion **WE1a** inward from the opening.

In addition, the second electric connection structure **540** includes a second circuit side connection body **542** without having the second electric wire side connection body **41** described above (FIG. 17 and FIG. 18). As in the previous example, the second circuit side connection body **542** is provided on a second circuit connection member **513** having a main body **513a** and a second circuit side connection body **513b**, and uses the second circuit side connection body **513b** (FIG. 17 and FIG. 18). The second circuit side connection body **542** has an elastic piece **542a** similar to that of the second circuit side connection body **42** (**13b**) described above, and has a contact portion **542b** provided at a free end of the elastic piece **542a** and directly electrically connected to the intermediate connection portion **WE2a** of the second electric wire **WE2** (FIG. 17 and FIG. 18). The contact portion **542b** in this example has a U-shape (FIG. 19). The contact portion **542b** is open to a side of the intermediate connection portion **WE2a** of the second electric wire **WE2**, and inserts the intermediate connection portion **WE2a** inward from the opening.

That is, the first circuit side connection body **532** in this example is formed to be directly electrically connected to the intermediate connection portion **WE1a** of the first electric wire **WE1**. The first circuit side connection body **532** is directly electrically connected to the intermediate connection portion **WE1a** of the first electric wire **WE1** by an elastic force directly applied to the intermediate connection portion **WE1a**. In addition, the first clamping body **524** in this example is formed to directly clamp the intermediate connection portion **WE1a** of the first electric wire **WE1** between the first clamping body **524** and the contact portion **532b** of the first circuit side connection body **532**. In addition, the second circuit side connection body **42** in this example is formed to be directly electrically connected to the intermediate connection portion **WE2a** of the second electric wire **WE2**. The second circuit side connection body **42** is directly electrically connected to the intermediate connection portion **WE2a** of the second electric wire **WE2** by an elastic force directly applied to the intermediate connection portion **WE2a**. In addition, the second clamping body **25** in this example is formed to directly clamp the intermediate connection portion **WE2a** of the second electric wire **WE2** between the second clamping body **25** and the contact portion **42b** of the second circuit side connection body **42**.

When the first housing member **21** and the second housing member **22** are fit to each other, the pressing portion **524b** and the contact portion **532b** insert the intermediate connection portion **WE1a** of the first electric wire **WE1** into the respective U-shapes inward from the respective openings (FIG. 20), and are disposed to face each other in the axial direction of the intermediate connection portion **WE1a** (FIG. 18). The pressing portion **524b** and the contact portion **532b** are disposed close to each other in the axial direction. In this way, the pressing portion **524b** and the contact portion **532b** can interpose the intermediate connection portion **WE1a** in the electric wire clamping direction by bottom portions of the respective U-shapes, and exert a stable contact load on the intermediate connection portion

WE1a. In addition, the pressing portion **524b** and the contact portion **532b** can surround the intermediate connection portion **WE1a** of the first electric wire **WE1** on the inner side of the respective U-shapes (FIG. 20). Therefore, in the noise filter **1F**, the invention can be applied to the first electric wire **WE1** in which the core wire **WEa** is a single wire, and can be applied to the first electric wire **WE1** in which the core wire **WEa** is an aggregate of a plurality of strands since separation of the strands can be suppressed. In addition, the first electric wire **WE1** may be obtained by welding and solidifying the plurality of strands in the intermediate connection portion **WE1a** described above using thermo-compression bonding, etc.

In addition, when the first housing member **21** and the second housing member **22** are fit to each other, the pressing portion **525b** and the contact portion **542b** insert the intermediate connection portion **WE2a** of the second electric wire **WE2** into the respective U-shapes inward from the respective openings (FIG. 20), and are disposed to face each other in the axial direction of the intermediate connection portion **WE2a** (FIG. 18). The pressing portion **525b** and the contact portion **542b** are disposed close to each other in the axial direction. In this way, the pressing portion **525b** and the contact portion **542b** can interpose the intermediate connection portion **WE2a** in the electric wire clamping direction by bottom portions of the respective U-shapes, and exert a stable contact load on the intermediate connection portion **WE2a**. In addition, the pressing portion **525b** and the contact portion **542b** can surround the intermediate connection portion **WE2a** of the second electric wire **WE2** on the inner side of the respective U-shapes (FIG. 20). Therefore, in the noise filter **1F**, the invention can be applied to the second electric wire **WE2** in which the core wire **WEa** is a single wire, and can be applied to the second electric wire **WE2** in which the core wire **WEa** is an aggregate of a plurality of strands since separation of the strands can be suppressed. In addition, the second electric wire **WE2** may be obtained by welding and solidifying the plurality of strands in the intermediate connection portion **WE2a** described above using thermo-compression bonding, etc.

In this way, since the number of parts is reduced in the first electric connection structure **530** and the second electric connection structure **540**, the noise filter **1F** can attempt weight reduction, improvement in assembling workability, and cost reduction.

Modification of Noise Filter **1A**

Incidentally, in the noise filter **1A** described above, although not illustrated, the respective contact portions **32b** and **42b** may be formed to have pressure welding blades disposed to face each other at an interval. A slit is formed in the coating **WEB** of the first electric wire **WE1** inserted therebetween, and the pressure welding blade of the contact portion **32b** is wedged into the core wire **WEa** of the first electric wire **WE1**. Therefore, the contact portion **32b** can pressure-weld and fix the first electric wire **WE1** in an electrically connected state by each pressure welding blade. In addition, a slit is formed in the coating **WEB** of the second electric wire **WE2** inserted therebetween, and the pressure welding blade of the contact portion **42b** is wedged into the core wire **WEa** of the second electric wire **WE2**. Therefore, the contact portion **42b** can pressure-weld and fix the second electric wire **WE2** in an electrically connected state by each pressure welding blade.

As described above, in the noise filter **1** (**1A**, **1B**, **1C**, **1D**, **1E**, and **1F**) of the present embodiment, the filter circuit **10** is interposed between the intermediate connection portion **WE1a** of the first electric wire **WE1** and the intermediate connection portion **WE2a** of the second electric wire **WE2** bundled in the trunk line **WT** of the wire harness **WH**, and the filter circuit **10** is electrically connected to the respective

intermediate connection portions WE1a and WE2a. Therefore, the noise filter 1 (1A, 1B, 1C, 1D, 1E, and 1F) of the present embodiment becomes a simple noise filter not requiring adjustment of the filter circuit characteristic taking the noise component of the intermediate electric wire into consideration unlike the past. Furthermore, the noise filter 1 (1A, 1B, 1C, 1D, 1E, and 1F) of the present embodiment may not use a ground terminal, and thus can attempt reduction in size or weight of the frame. Further, the noise filter 1 (1A, 1B, 1C, 1D, 1E, and 1F) of the present embodiment uses elasticity for electric connection between the first electric wire WE1 and the second electric wire WE2, and the filter circuit 10, and thus can attempt reduction in size of the frame and suppression of a steep rise in cost and becomes a noise filter having high versatility which can cope with electric wires having various outer diameters (the first electric wire WE1 and the second electric wire WE2). In addition, the noise filter 1 (1A, 1B, 1C, 1D, 1E, and 1F) of the present embodiment can absorb a dimensional variation of each component and exert a stable contact load on the intermediate connection portion WE1a of the first electric wire WE1 and the intermediate connection portion WE2a of the second electric wire WE2 by such a connection structure using elasticity, thereby attempting improvement in the conduction quality. In addition, the wire harness WH of the present embodiment includes such a noise filter 1 (1A, 1B, 1C, 1D, 1E, and 1F), and can achieve an effect obtained by this noise filter 1 (1A, 1B, 1C, 1D, 1E, and 1F).

Incidentally, in the noise filter 1 (1A, 1B, 1C, 1D, 1E, and 1F) of the present embodiment, the filter circuit 10 is interposed between the first electric wire WE1 and the second electric wire WE2 in illustration. Thus, in illustration, elasticity is used for both the electric connection structure between the first electric wire WE1 and the filter circuit 10 and the electric connection structure between the second electric wire WE2 and the filter circuit 10 (first and second electric connection structures). However, in the noise filter 1 (1A, 1B, 1C, 1D, 1E, and 1F) according to the present embodiment, elasticity may be used for one of the connection structures, and the other one may be configured as another connection structure.

In a noise filter according to the embodiment, an electric connection structure between an intermediate connection portion of an electric wire and a circuit side connection body uses an elastic force of the circuit side connection body. Therefore, when compared to a noise filter in which a connection structure corresponds to a fitting structure of male and female terminal portions as in the past, this noise filter can achieve a reduction in size of an electric connection structure. Therefore, this noise filter can attempt a reduction in size of a frame. In addition, a wire harness according to the invention includes such a noise filter, and can achieve an effect obtained by this noise filter.

Although the invention has been described with respect to specific embodiments for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art that fairly fall within the basic teaching herein set forth.

What is claimed is:

1. A noise filter comprising:

a filter circuit including a noise reduction element that reduces a noise component, a conductive first circuit connection member to which a first connection portion of the noise reduction element is electrically connected, and a conductive second circuit connection member to which a second connection portion of the noise reduction element is electrically connected; and
an electric connection structure that electrically connects an intermediate connection portion of a core wire of an

electric wire to one of the first circuit connection member and the second circuit connection member, wherein

the electric connection structure includes a circuit side connection body provided in the one of the first circuit connection member and the second circuit connection member and indirectly or directly electrically connected to the intermediate connection portion of the core wire of the electric wire by an elastic force indirectly or directly exerted on the intermediate connection portion of the core wire of the electric wire, and the elastic force biases the circuit side connection body away from the one of the first circuit connection member and the second circuit connection member.

2. The noise filter according to claim 1, wherein the electric connection structure includes an electric wire side connection body physically and electrically connected to the intermediate connection portion of the core wire of the electric wire, and

the circuit side connection body is formed to be indirectly electrically connected to the intermediate connection portion of the core wire of the electric wire by an elastic force exerted on the electric wire side connection body.

3. The noise filter according to claim 1, wherein the intermediate connection portion of the core wire of the electric wire is a part obtained by collectively fixing a plurality of strands forming the core wire of the electric wire, and

the circuit side connection body is formed to be directly electrically connected to the intermediate connection portion by an elastic force exerted on the intermediate connection portion of the core wire of the electric wire.

4. A noise filter comprising:

a filter circuit including a noise reduction element that reduces a noise component, a conductive first circuit connection member to which a first connection portion of the noise reduction element is electrically connected, and a conductive second circuit connection member to which a second connection portion of the noise reduction element is electrically connected; and

an electric connection structure that electrically connects an intermediate connection portion of a core wire of an electric wire to one of the first circuit connection member and the second circuit connection member; and

a housing that accommodates the filter circuit, the intermediate connection portion of the core wire of the electric wire, and the electric connection structure,

the electric connection structure includes a circuit side connection body provided in one of the first circuit connection member and the second circuit connection member and indirectly or directly electrically connected to the intermediate connection portion of the core wire of the electric wire by an elastic force indirectly or directly exerted on the intermediate connection portion of the core wire of the electric wire, and wherein the housing has a clamping body that indirectly or directly clamps the intermediate connection portion of the core wire of the electric wire between the circuit side connection body and the clamping body.

5. The noise filter according to claim 4, wherein the electric connection structure includes an electric wire side connection body physically and electrically connected to the intermediate connection portion of the core wire of the electric wire, and

the circuit side connection body is formed to be indirectly electrically connected to the intermediate connection portion of the core wire of the electric wire by an elastic force exerted on the electric wire side connection body.

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6. The noise filter according to claim 4, wherein the intermediate connection portion of the core wire of the electric wire is a part obtained by collectively fixing a plurality of strands forming the core wire of the electric wire, and

the circuit side connection body is formed to be directly electrically connected to the intermediate connection portion by an elastic force exerted on the intermediate connection portion of the core wire of the electric wire.

7. A wire harness comprising:
a trunk line including an electric wire; and
a noise filter that reduces a noise component, wherein the noise filter includes

a filter circuit including a noise reduction element that reduces a noise component, a conductive first circuit connection member to which a first connection portion of the noise reduction element is electrically connected, and a conductive second circuit connection member to

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which a second connection portion of the noise reduction element is electrically connected, and

an electric connection structure that electrically connects an intermediate connection portion of a core wire of the electric wire to one of the first circuit connection member and the second circuit connection member, and

the electric connection structure includes a circuit side connection body provided in one of the first circuit connection member and the second circuit connection member and indirectly or directly electrically connected to the intermediate connection portion of the core wire of the electric wire by an elastic force indirectly or directly exerted on the intermediate connection portion of the core wire of the electric wire, and the elastic force biases the circuit side connection body away from the one of the first circuit connection member and the second circuit connection member.

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